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Editorial

A PLEA FOR SIMPLER SURGICAL TERMINOLOGY

THE fact that medical literature is full of confusing terms is quite apparent to all readers. It has facetiously been said that text books are written to perpetuate past errors; and if this statement has any foundation in fact, it is to be found in most medical text books.

It is difficult enough for medical students and residents to understand the basic principles of the subject under discussion without being confused by the many terms applied to the same condition. It is my contention that in practically every branch of medicine and surgery too many proper names have been applied to certain diseases or operations. I believe that every disease should be described according to its pathology and the operation used to correct any condition should be accurately described according to the technic used. In doing this we would eliminate all proper names and everyone would readily understand the topic under discussion.

In this paper an attempt will be made to clarify and simplify the situation insofar as the subject of abdominal hernia is concerned. This subject should be one of the simplest in surgical literature but it has been made confusing because of the many unnecessary terms that have been handed down from our predecessors.

In presenting the subject to medical students or interns they need first be given a simple and concise definition of abdominal hernia which is nothing more than a protrusion of a tissue or organ through an abnormal opening in the abdominal wall. The next question to ask about a hernia is its location and its etiology. Having determined this, the only other classification necessary is whether it is reducible or irreducible and, if irreducible, is it strangulated. There is no need for such terms as incarcerated hernia which is nothing but an irreducible hernia. The term bubonocele should be discarded. Such terms as complete and incomplete hernia as well as potential or incipient hernia should suffer the same fate. Thus for example, anyone can readily understand the situation when an inguinal hernia is described as an irreducible left scrotal inguinal hernia. We know from the terminology that it is a large hernia which descends into the scrotum and is irreducible. Every other type of hernia could be described using the same simple, concise terminology.

The greatest confusion arises in discussing the types of operation used to repair hernias. Thus, we hear the names of Bassini, Halstead, Willys Andrews, Ferguson, Gallie, Wangenstein, MacArthur, Hotchkiss, Moskowitz, Blake, Mayo and many others applied to various procedures used to correct the condition. In my opinion, the student should be told the

principles involved in the cure of a hernia, namely, to reduce the contents; high ligation of the sac wherever possible or advisable and closure of the defect in the abdominal wall. If these principles are understood, it is only necessary for the student to know that various suture materials or tissue can be used to close the defect and the operation must be suited to the individual patient. Thus, in most indirect inguinal hernias a high ligation of the sac is all that is necessary. It may occasionally be necessary to use fascial sutures in direct hernias to close the defect. The source of the suture material is immaterial; and simply because the fascia is taken from the thigh or external oblique aponeurosis, is no justification for adding another name to a recognized procedure and so further confuse the young surgeon. Thus, the student will learn that in closing the abdominal defect he must meet the problem as it presents itself at operation and use the materials available if adequate and, if not, to use fascia from the thigh or elsewhere. All the above mentioned names have been applied to various procedures to accomplish the closure of the defects and in most instances each name implies only some slight modification of an antecedent operation. It seems to me that anyone understanding the above principles will find it entirely unnecessary to remember all the surgeons' names that in the course of time have been applied to certain methods of repair. There is only one method of repair of a hernia and that is ligation of the sac and closure of the defect; how this latter is done is entirely dependent on the type of tissue found during operation at the operative site; and if these tissues are not satisfactory for an adequate repair, other means must be sought and this can be accomplished by the use of fascia or flaps taken from other parts of the body, usually the thigh but this is rarely necessary.

My experience in teaching this subject to students and interns has been that they are confused by the galaxy of names and forget completely the underlying principles involved. There is no significant difference between the Halstead and Willys Andrew's operations, nor is there any great difference between the MacArthur and Gallie operations. The only difference in the latter two operations is the source of the fascia. So why should two names be applied to practically the same operation?

This confused terminology is true not only of the subject of hernia but goes throughout most of our surgical literature; and since the subject of hernia is such a simple one, it would seem to me to be a good starting point for some housecleaning in the realm of medical literature.

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OSTEOID OSTEOMA*

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THIS peculiar lesion has long been recognized as a true benign tumor of bone, one requiring differentiation from malignant types. Jaffe in 1935 was the first to classify it as osteoid osteoma; and while pathologists and clinicians in general have accepted this designation, Brailsford, the distinguished British roentgenologist, is inclined to regard the lesion as a low-grade cortical or subcortical bone infection. In favor of this view he advances the following arguments: (1) No known benign tumor of bone produces so marked a reaction at a distance from the wall of the tumor itself. (2) No form of accepted bone tumor can be cured by mere removal or unroofing of the tumor-bearing cavity while leaving behind surrounding reactive tissue. (3) The roentgenographic appearance does not suggest that this lesion is a benign tumor of bone; in fact, a fairly impressive group of these lesions cannot be distinguished roentgenographically from chronic sclerosing osteitis.

The authors are inclined to favor Jaffe's concept that osteoid osteoma is a benign neoplastic lesion *sui generis*. It appears as a small, ovoid, radiolucent area which is sharply circumscribed and surrounded by a far larger area of bone sclerosis. While it may be medullary in origin, it tends to appear in a cortical or subcortical position and the surrounding perifocal sclerosis is thus apt to be eccentric.

The authors' experience is based upon a group of ten cases in which the diagnosis was apparently satisfactorily confirmed.

Sex. All ten patients were males. This is a surprising observation in view of the ratio of males to females noted in other series, *e.g.*, in Jaffe's, 2 to 1; in Lewis', 8 to 3; and in Sherman's, 3 to 2. Obviously the disease has a distinct predilection for the male sex.

Age. Osteoid osteoma occurs most frequently in childhood and in early adult life. In our series the ages ranged from two to twenty years, with an average of 13.7 years; in seven of the cases the ages were from fifteen to twenty years. Lewis found the average age to be 16.1 years and more than half of Sherman's patients were between five and fifteen years old.

Clinical Findings. The principal features noted were pain, swelling and disability, present either singly or in combination, although the most constant complaint was pain. The duration of symptoms ranged from three to twelve months with an average of 5.8 months; this is shorter by far than that found by Jaffe (six months to two years) or Lewis (eleven months). While regional adenopathy was mentioned as being present in two instances, we do not regard it as significant. In all cases the past or family history was essentially negative. Local antecedent injury was mentioned only three times and we share Jaffe's viewpoint that trauma is not an etiologic factor. The lower extremity was found to be affected more often than the upper, *i.e.*, the tibia in seven of our cases. Table I indicates the site of involvement in the various series.
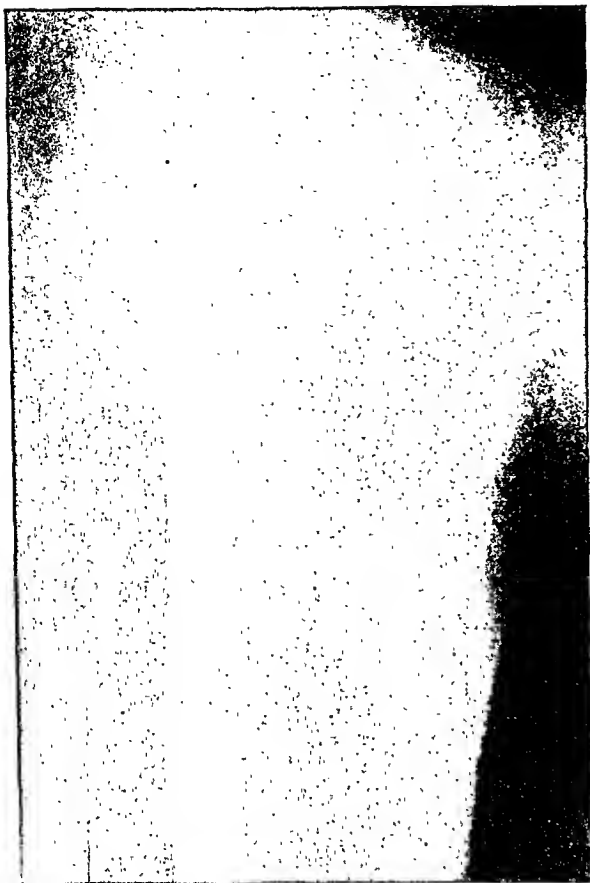
Fig. 1. Tibia of twenty-three year old female with two-year history of pain, redness and swelling of left leg. Roentgenographic interpretation was osteoid osteoma but pathologic examination revealed inflammatory tissue and cultures showed the organism to be hemolytic staphylococcus aureus, thus establishing the diagnosis as bone abscess.

TABLE I
NO. OF CASES IN SERIES

Bone Involved	Memorial Hospital	Jaffe's	Sherman's	Lewis'
Tibia.........	7	17	4	4
Femur........	2	14	7	3
Fibula........	..	6		
Humerus......	..	5	1	1
Vertebrae.....	..	4	7	1
Phalanx.......	1	2	4	1
Total........	10	48	23	10

Differential Diagnosis. Among the many conditions which may at times be confused with osteoid osteoma are: osteomyelitis of chronic sclerosing type, Brodie's abscess, periostitis, osteogenic sarcoma, Ewing's sarcoma (endothelioma of bone), bone repair after green-stick fracture and osteoma.

It may be extremely difficult if not virtually impossible to make a clinical or roentgenographic distinction between osteoid osteoma and chronic sclerosing osteitis, or between osteoid osteoma and a simple cortical bone abscess of the Brodie type (Fig. 1.) Roentgenographically, untreated Ewing's sarcoma is not readily confused with osteoid osteoma but osteogenic sarcoma of the sclerosing type may bear at least a superficial resemblance to it and we have seen several cases that have been referred with that diagnosis. The reparative phase of a green-stick fracture, unrecognized early in its course, may simulate fairly closely an osteoid osteoma but here, as in all of the other entities mentioned with the exception of Brodie's abscess, an area of radiolucency such as is seen in the nidus of an osteoid osteoma is conspicuously lacking.

Roentgenographic Findings. Few lesions of bone have a more consistently characteristic roentgenographic picture. Early in the course of the disease, a small radiolucent area is seen surrounded by a dense zone of opaque bony sclerosis. Later on while this area may become ossified and consequently radiopaque, the surrounding zone of sclerosis still persists. The nidus may not appear on a routine roentgenogram but may be visualized when films are taken at different degrees of penetration. With experience one may become highly proficient in the interpretation of these films. In the Memorial Hospital series a roentgenographic diagnosis of osteoid osteoma was made in nine of the ten cases; the tenth was diagnosed as chronic productive osteitis and chronic osteomyelitis.

Pathology. The histogenesis of osteoid osteoma is divided by Jaffe into three phases: (1) Initial stage characterized by prominence of proliferating and compacted osteoblasts; (2) intermediate phase in

which the osteoid is in various stages of calcification; (3) mature stage with densified trabeculae of highly calcified bone. If the lesion develops in spongiosa, it is surrounded by spongy osseous tissue and becomes sclerotic; if there is cortical development, periosteal new bone formation forms a zone of bony sclerosis.

Bacteriology. Cultures were taken in three of our cases and were consistently negative. This finding coincides with the observations of other investigators and tends to establish the fact that osteoid osteoma is not a condition that is attributable to infection by any of the common organisms.

Serology. In all but two cases of our series serologic tests for syphilis were made and were uniformly negative.

Blood Chemistry Findings. Serum calcium, alkaline phosphatase and inorganic phosphorus determinations were carried out in four cases and in every instance the findings were normal.

Treatment. In our experience the method that has yielded uniformly successful results is: complete removal by osteotome or bone chisel of the block of bone enclosing the nidus. Even incomplete curettage of this area has in some instances resulted in relief of symptoms. The main objection to curettage is that it does not provide for a definite microscopic diagnosis, which is an easy matter if a block of bone containing the entire nidus is submitted to the pathologist. A roentgenographic examination will establish the fact that the segment of bone removed contains the complete nidus. In several of our cases at the first operative attempt the nidus was either partly or completely missed and the report of the pathologist indicated sclerotic bone only. It is not always an easy matter to come down upon the exact site of the nidus and to remove it completely without sacrificing too much adjacent bone; therefore, it is wise to have roentgenograms on hand in the operating room and to take careful measurements.

We have had very little experience with roentgen therapy in this type of tumor and are unable to state its effectiveness. In general we believe that any benign lesion of bone that is accessible to surgery should be treated by that method rather than by irradiation.

CASE REPORTS

CASE I. J. O., a two and one-half year old white male, was admitted with a seven months' history of pain, disability and swelling located on the anteromedial aspect of the mid-upper third of the left tibia. No regional adenopathy was palpable. The laboratory findings were negative; serum calcium was 10.9, alkaline phosphatase 6.9 and serum inorganic phosphorus 5.08.

Provisional diagnosis: Green-stick fracture and osteomyelitis.

Roentgenographic findings reported osteoid osteoma. At operation a 5 by 3 cm. bony swelling seemingly filled with granulations was found. The lesion was treated by curettage. The pathologic report was osteosclerosis; osteoid osteoma. (Fig. 2.)

Fifteen months postoperatively the patient was asymptomatic with no evidence of recurrence of the nidus by roentgenography.

CASE II. J. L., a twelve year old male, was admitted with a six months' history of pain, more severe at night, disability and swelling of the middle and upper third of the left tibia. No regional adenopathy was palpable.

Provisional diagnosis: Osteomyelitis.

Roentgenographic findings revealed osteoid osteoma. At operation dense bone with an area of softening was located. The treatment consisted of sharp dissection and curettage. The pathologist reported osteoid osteoma.

Five months postoperatively physical examination revealed only minimal edema of the operative site. Roentgenograms showed the defect to be largely filled in and there was no evidence of a recurrence.

CASE III. S. M., a nineteen year old white male, was admitted with a history of pain of three months' duration. The lesion was located in the medial and upper aspect of the lower third of the right humerus. He had a past history of fracture of the right wrist at the age of fourteen. No regional adenopathy was palpable. The laboratory findings were negative; serum calcium 11.8, alkaline phosphatase 3.0 and serum inorganic phosphorus 3.58.
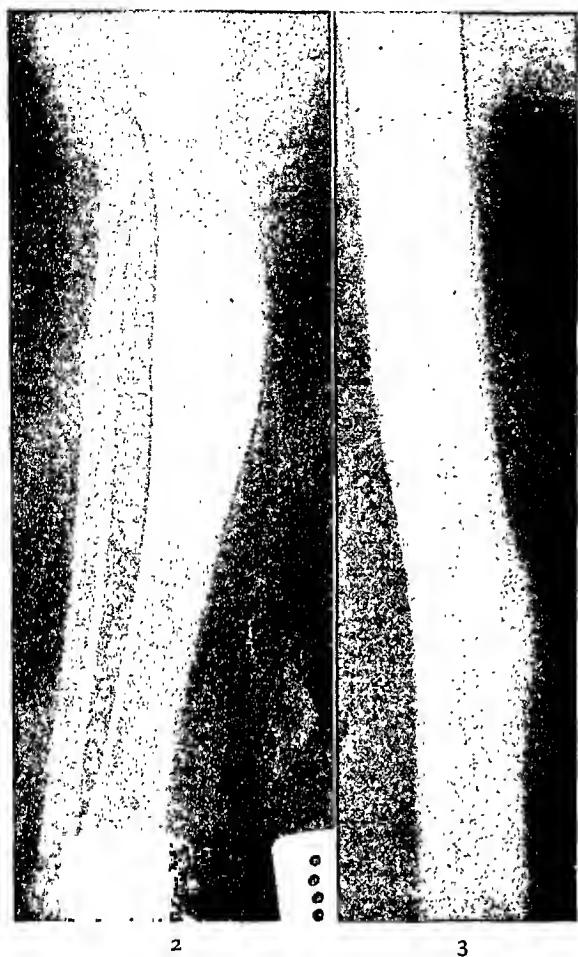
FIG 2. Case i. Appearance of lesion in a two and a half year old white male who had pain, swelling and disability of seven months' duration. The lesion so clearly visualized in this view could not be seen in the anteroposterior view; this emphasizes the necessity for taking different views from several angles and with varying degrees of penetration.

FIG. 3. Case iii. Humerus of nineteen year old white male with three months' history of pain. Note characteristic nidus surrounded by zone of bony sclerosis.

Provisional diagnosis: Periostitis, osteoid osteoma.

The roentgenographic report was osteoid osteoma. At operation a firm osseous tumor was found with a 3 cm. nidus. (Fig. 3.) This was treated by sharp block dissection and curettage. The pathologist reported sclerotic cortical bone; osteoid osteoma.

The patient was asymptomatic when discharged from the hospital and it was impossible to trace him thereafter.

CASE IV. A. L. B., a sixteen year old white male, was admitted with a history of disability of seven months' duration associated with swelling of the anterior mid-third of the right tibia. The onset was alleged to have followed a fall in which the patient struck his right tibia. No regional adenopathy was palpable. The laboratory findings were negative; serum calcium 12.8, alkaline phosphatase 6.1 and serum inorganic phosphorus 3.8.

Provisional diagnosis: Sprain and osteogenic sarcoma.

The roentgenographic report was osteitis; osteoid osteoma. At operation a bony elevation measuring 4 by 3 cm. was found within which a 1 cm. lesion was noted. This was treated with sharp excision. The pathologist reported osteoid osteoma.

Twenty months postoperatively the patient was asymptomatic. Films made nine months after operation revealed bone regeneration, periosteal reaction and swelling of the soft parts.

CASE V. E. R., a fifteen year old white male, was admitted with a history of pain, disability and tenderness over the posteromedial aspect of the distal third of the left tibia for a period of two months. The onset allegedly followed a blow from a bowling pin.

Provisional diagnosis: Osteomyelitis, Ewing's tumor, osteogenic sarcoma.

Roentgenographically, osteoid osteoma was revealed. At operation a small area of rarefaction 1.5 by 2 cm. was found surrounded by sclerosing bony cortex and thickened periosteum. The treatment consisted of block dissection and currettage. The pathologist reported chronic periostitis; dense bone.

Seven months postoperatively physical examination showed a favoring of the affected leg with slight limping associated with pain and tenderness at the upper aspect of the wound. There was minimal edema below the operative site. Roentgenographic report seven months postoperatively disclosed an apparent increase in the process in the lower third of the tibia. Periosteal new bone was evident for a distance of 5 or 6 cm. on both edges of the tibia when viewed in the anteroposterior project'on. Within the expanded area of increased density in the lower tibia there was an irregular area of decreased density measuring approximately 1 by 3 cm., within which there was a linear area of increased density (the report suggested that this might represent a bone sequestrum at the operative site). There was a soft-tissue swelling noted over the bone lesion. The roentgenographic findings were interpreted as re-
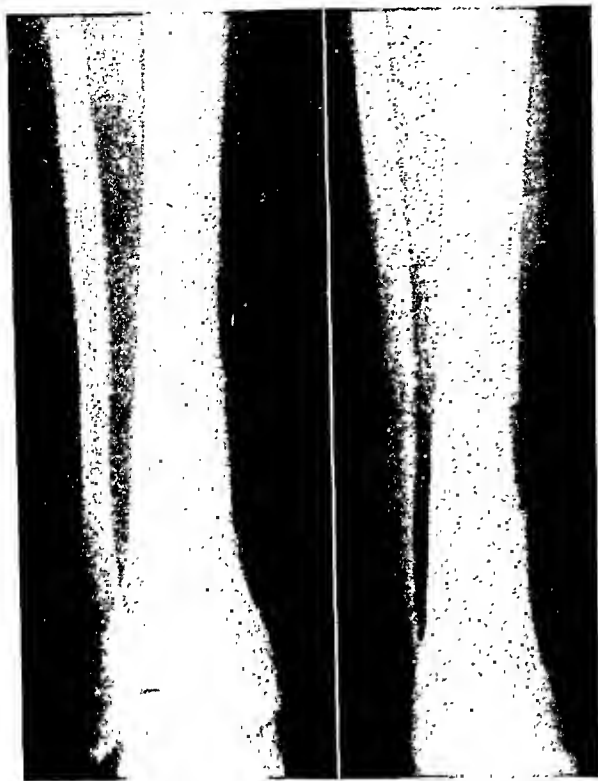
FIG. 4. Case v. A, tibia of fifteen year old white male with pain, disability and tenderness of two months' duration. The lesion is seen in the distal third, posterior aspect. B, postoperative defect in case shown in Figure 4A. In this instance nidus was completely missed. However, technic of recommended excision of lesion, as seen, is sharp block dissection. A second operation was successful in completely removing the nidus.

vealing progressive changes within an osteoid osteoma that had not been completely removed at operation. (Fig. 4.)

CASE vi. R. G. H., a two year old white male, was admitted with a history of pain, disability and swelling of the anteromedial aspect of the upper third of the left tibia of three months' duration. Examination revealed enlargement of the left femoral and inguinal nodes.*

Provisional diagnosis: Osteomyelitis, Ewing's tumor, Brodie's abscess, osteogenic sarcoma, osteoid osteoma.

Roentgenographically, osteoid osteoma was reported. At operation a prominence of bone with a small nidus of soft bone was found surrounded by sclerotic bone. Treatment consisted of block dissection and curettage. The

* Reoperation was performed on March 4, 1948, when the nidus was completely extirpated; microscopic diagnosis: osteoid osteoma.

FIG. 5. Case vi. Section of osteoid osteoma taken at periphery of lesion showing typical appearance (magnification approximately 100 X).

pathologist reported osteoid osteoma. (Fig. 5.) Culture showed no growth after five days.

Roentgenographic examination on the day of discharge showed that the nidus had been removed. The patient failed to return for follow-up examination.

CASE vii. G. A. Z., an eighteen year old white male, was admitted with a history of pain and disability of five months' duration. The lesion was located on the posterior aspect of the upper third of the right tibia. According to the patient, two years previously he had sprained his right ankle; healing required four or five months and there was some recurrent difficulty one year later. The femoral and inguinal nodes were enlarged to palpation. Laboratory findings were negative; serum calcium was 11.2, alkaline phosphatase 4.4, and serum inorganic phosphorus 4.8.

Provisional diagnosis: Osteogenic sarcoma.

Roentgenographically, the report was osteoid osteoma. At operation a bony density was found with prominence of 5 by 3 cm. with no central area of rarefaction noted. Treatment was by sharp block dissection, curettage and zinc chloride cauterization. The pathologic specimen revealed sclerotic bone.

The roentgenogram taken upon discharge showed complete extirpation of the lesion. Three months postoperatively the patient still complained of occasional pain at night and he was favoring the operative leg.

Fig. 6. Case ix. Metacarpal of twenty year old white male with swelling and pain of one year's duration. Lesion diagnosed as osteoid osteoma by roentgenographic and microscopic study of specimen removed at operation.

Case viii. H. M., a fifteen year old white male, was admitted with a lesion situated at the junction of the middle and upper thirds of the right femur. He complained of pain which was more severe at night and which was associated with disability over a period of five months.

Provisional diagnosis: Neuritis, bone cyst, osteogenic sarcoma.

Roentgenographic findings were chronic productive osteitis and chronic osteomyelitis. At the first operation a localized area of bone destruction measuring 5×1.5 cm. in diameter was found. The pathologist reported chronic productive rarefying osteitis, chronic fibrosing osteitis and chronic osteomyelitis. The culture showed no growth.

A roentgenogram made one month postoperatively revealed a lesion that was reported to be congenital rather than pathologic. Two years after the operation the patient still complained of occasional pain.

(Note: This patient has had three operations for pain. Because of subsequent military service it was assumed that his postoperative course was uneventful. This may be one of those cases which illustrate the need of complete extirpation of the nidus in order to obtain a cure.)

Case ix. M. R., a twenty year old white male, was admitted with a history of pain and swelling of the proximal phalanx of the right index finger of one year's duration. No regional adenopathy was palpable.

Provisional diagnosis: Chronic productive dactylitis, osteochondroma.

The roentgenographic finding was osteoid osteoma. (Fig. 6.) At operation a 3 cm. area of bone production was found on the radial aspect of the right index finger. Treatment was by sharp block excision. The pathologist reported —osteoid osteoma. The culture from the cavity showed no growth in several days.

This case is too recent for a satisfactory postoperative evaluation.

Case x. H. A., an eighteen year old white male, was admitted with a history of swelling and pain in the middle third and medial aspect of the right tibia of eight months' duration. The onset allegedly dated back to a kick in the right leg received while playing football. No significant inguinal or femoral adenopathy was noted.

Provisional diagnosis: Osteomyelitis, Brodie's abscess, osteoma.

Roentgenographically, osteoid osteoma was found. At operation a small tumor was located. This was treated by a sharp block excision. The pathologist reported—osteoid osteoma. Culture revealed no growth in five days.

The patient was asymptomatic on discharge. A postoperative roentgenogram revealed that the excision had failed to include the entire nidus area.

SUMMARY AND CONCLUSIONS

Osteoid osteoma is a well defined, localized, monostotic bone lesion, probably of benign origin, rather than a chronic subperiosteal bone abscess; its etiology is still uncertain. It has a predilection for the long bones of males in their second decade. It consists of radiolucent nidus, measuring from 1 to 2 cm. in diameter, surrounded by a circumscribed zone of sclerotic bone which fades out into normal bone. This perifocal zone may be eccentrically placed and may sometimes, but not always, alter the contour of the affected bone.

Because osteoid osteoma gives rise to symptoms of pain, tenderness, disability and sometimes mild swelling, it has been, and doubtless will continue to be, mistaken either for early sclerosing osteogenic sarcoma or for circumscribed bone abscess.

The radiolucent area which represents the nidus is not always apparent on routine roentgenograms; and when not seen, the condition may be regarded as sclerosing osteitis of Garré. Films made with varying degrees of penetration will nearly always reveal the nidus.

Treatment consists of removal of the nidus *en bloc*. This completely relieves the symptoms and also permits an accurate diagnosis since it is the osteoid tissue of the nidus itself which is characteristic of the disease. If the operator misses the nidus and resects merely a segment of adjacent sclerotic bone, the symptoms will persist; but relief will be obtained if the overlying cortical bone is unroofed and the nidus exposed and curetted. In every case it is important to close the wound in layers without drainage.

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TRIPLE ARTHRODESIS*

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THE value of triple arthrodesis in treatment of traumatic subtalar arthritis following fractures of the calcaneus has been established. It is the purpose of this brief report to confirm previous experiences and to advocate the procedure in the definitive treatment of fractures involving the proximal tarsal joints. Observations were made in a series of eighty-two cases, mostly war compound injuries, operated on at Fletcher General Hospital, Cambridge, Ohio during a one-year period (November 1, 1944 to November 1, 1945).

Indications. Indication for operation was a painful foot following a simple or compound fracture involving any or all of the proximal tarsal bones and their joint surfaces: talus, calcaneus, cuboid and navicular. The procedure was not performed until a thorough tryout of unprotected walking for a period of one or two months was made. In compound fractures cessation of all drainage was required.

Technic of Operation. Either the Kocher or the anterolateral approach was used. The sinus tarsi was cleaned out. The surfaces of the calcaneocuboid, talonavicular and subtalar joints were thoroughly denuded of cartilage. Corrective wedges were removed if indicated. The sinus tarsi was filled with bone chips obtained from the anterior portion of the calcaneous and other available bone. An attempt was made to obliterate the remaining dead space in the region of the sinus tarsi with soft tissue without using too many deep sutures. The skin was closed with continuous or interrupted sutures of silk, dermal or wire. The foot was immobilized in a long leg plaster cast with the heel in a neutral or slight valgus position, the ankle at 90 degrees dorsiflexion and the knee in extension.

Postoperative Course. The plaster cast was immediately split throughout. High elevation was ordered to minimize the swelling. Two weeks postoperatively an unpadded long leg cast was applied; adjustments of position were made at that time without anesthesia. The patient was allowed up with crutches without weight bearing until six weeks from the date of operation. The long leg cast was then changed to an unpadded walking boot in which the patient walked for another six weeks preferably without any external support. The use of crutches was strictly prohibited. Occasionally the walking boot was applied after the first· change of plaster two weeks postoperatively. The plaster cast was removed three months from the date of operation. The patient was immediately instructed to walk using a firm low-quarter shoe. An Ace bandage and a longitudinal arch support were supplied. Physiotherapy was instituted with stress on active walking exercises, mostly given in the remedial gymnasium. Treatment was carried out for four to eight weeks after removal of the cast. The patients were then routinely separated from military service with a certificate of disability for discharge.

Observations. A strictly statistical evaluation of the results does not seem indicated since none of these patients were observed longer than a few months after operation. The following facts, however, are of interest: All the patients stated that they were improved by the operation. Improvement was determined by relief of pain while walking, particularly over uneven ground, and by disappearance of swelling and edema. Limps were eliminated

or at least markedly improved. Arthrodesis of the involved joint alone resulted in persistent pain and had to be followed later by triple arthrodesis. X-ray examination three months postoperatively showed bony fusion of the involved joints in almost all cases. In the few cases in which fusion was not complete by x-ray the result still seemed to be satisfactory. Disappearance of the osteoporosis which had existed prior to operation was noted. There was no difference in the healing between the two types of incisions used. In several instances drainage and skin necrosis were found at the first and sometimes the second change of plaster, but in all but one patient healing of the wound was complete at the end of three months. This applied in cases in which initially a considerable breakdown of a scar (in compound fractures) occurred. The insertion of bone chips into the sinus tarsi was found to be of great value in obtaining fusion of the subtalar joint. Postoperative immobilization of the leg with the knee in complete extension was prompted by the earlier disappearance of edema than when the knee was immobilized in the flexed position. No difficulty was seen in correcting the alignment of the foot without anesthesia two weeks after the operation. The position of the heel seemed to be less important than previously believed. It appeared that a heel in neutral position resulted in a better gait than a heel in valgus position. Varus position was considered undesirable because of a poor gait. Unsupported weight bearing in a well applied unpadded walking boot according to the Boehler technic had a decided influence on the amount of swelling following removal of the plaster cast and the ability to walk. There was no difference in the results when the walking cast was used two weeks after operation. More than 80 per cent of the patients stated that they derived more benefit from walking exercises than from physiotherapy consisting of heat, massage and whirlpool. The latter treatment was continued only for experimental purposes. Use of an arch support was generally justified by improvement in the patient's gait and comfort. If the arch support caused discomfort, it was immediately discontinued. In a large number of cases the end result was so satisfactory that it appeared hardly justifiable to discharge the patient on a certificate of disability for discharge. In the earlier phase of the war the patient had been returned to duty.

CONCLUSION

Observations in a series of eighty-two cases of triple arthrodesis have been reported. The procedure has proved to be of excellent value in treatment of a painful foot following a fracture involving any of the proximal tarsal joints.

TREATMENT OF FRACTURES OF THE FOREARM WITH INTRAMEDULLARY PINS*

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AT the outset we must emphasize that most fractures of the shaft of the radius and ulna can be treated satisfactorily by closed manipulative methods or with some form of traction. Only a relatively small per cent of forearm fractures require open reduction and internal fixation. Even so normal function of the hand and forearm is dependent upon almost exact replacement of fractures of the long bones. Hence, in deciding upon the method of treatment it is not only essential to restore the fragments to normal position but to ensure preservation of the interosseous space between the radius and ulna. Forearm fractures which are difficult to reduce by closed methods or in which there is a likelihood of redisplacement during the period of healing are: (1) Transverse fractures of the shaft of one bone with overlapping of the fragments; (2) oblique fractures of a single bone with displacement; (3) comminuted fractures of one or both bones; (4) multiple fractures at different levels in the same bone; (5) irreducible fractures with overlapping; (6) Monteggia fractures (fractures of the upper third of the shaft of the ulna with anterior displacement of the head of the radius).

Complicated fractures of the forearm in which it is impossible to correct the displacement usually require open reduction with some type of internal fixation. Sometimes in transverse fractures open reduction alone with levering of the fragments until they become engaged is successful. Wire loops about the fragments or screws across the fracture line may be satisfactory in long oblique fractures. In some fractures which are not markedly comminuted appli-

cation of metal plates and screws to the bones will secure the fragments in proper position. However, it has been common experience that after such open reduction and internal fixation operations there is a strong tendency toward non-union of the fracture or the occurrence of low grade infection in the wound. In addition extensive dissection required to replace the fragments and to insert the internal fixation appliance often interferes with the blood supply to the fracture and delays healing of the bone. The necessarily wide exposure leaves a large scar which is often adherent to the bone. A metal plate applied to a subcutaneous bone such as the ulna may also produce a tender pressure point unless it is placed beneath the muscles. Finally, it is inadvisable to introduce plates and screws in the bones of young children for fear of interfering with their normal growth. Consequently, none of these methods of internal fixation has been universally applicable and various alternative procedures have been devised to immobilize the fracture fragments in good anatomic position without leaving large fixative applicances in the body.

Use of removable intramedullary wires and pins seems to offer a happier solution to these problems than anything that has been tried thus far. Forty years ago Lambotte, the great pioneer in operative treatment of fractures, experimented with intramedullary wires in fractures of the clavicle. In 1921 Hey-Groves reported the use of a steel pin in the medullary cavity for comminuted fractures of the femur. During the past few years Rush, Lambrinudi, Dickson, Murray, Souer and Kuntscher have revived
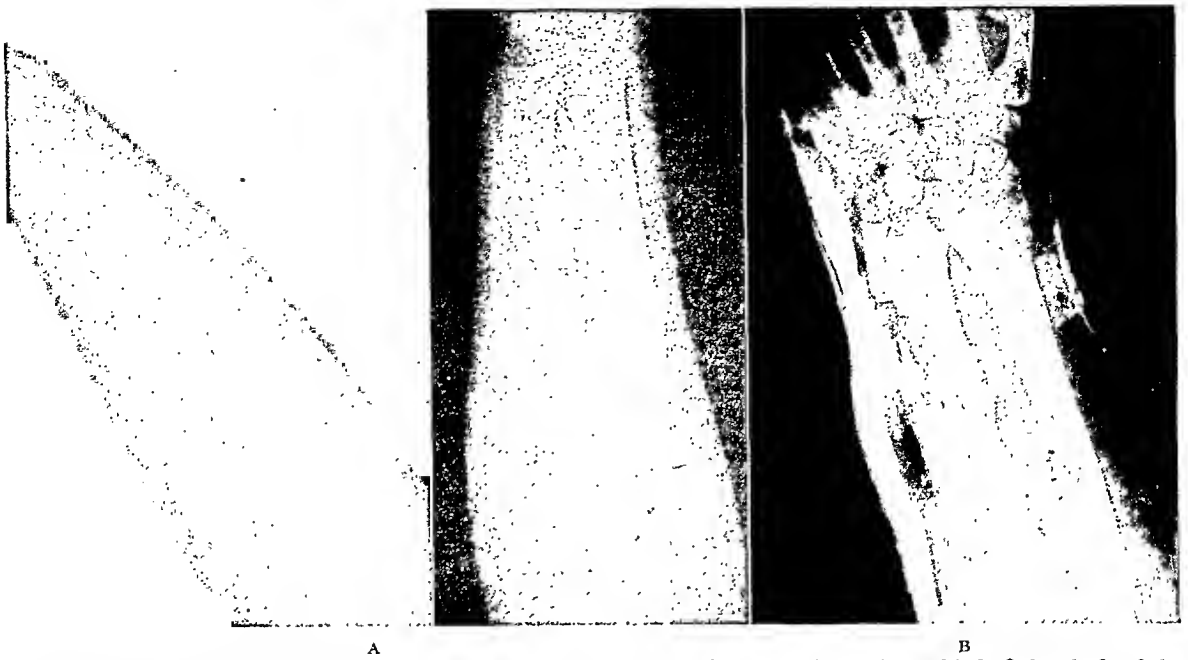
Fig. 1. A and B, F. M. S., a male, seventy years of age; oblique fracture of the distal third of the shaft of the ulna with tear of the distal radio-humeral ligaments.

interest in this method as an effective substitute for other types of internal fixation. In World War II German surgeons used Kuntscher's intramedullary pins extensively and they were brought to the attention of American surgeons when prisoners of war were liberated with such appliances still in the bones.

The technic of insertion of intramedullary wires and pins has so improved that the method has now become well standardized. While they have been used in fractures of the femur, tibia, humerus and forearm bones, this paper will only discuss their use in the forearm. Advantages of intramedullary fixation of fractures of the radius and ulna are: (1) Only a small incision is required; (2) there is only slight bleeding at the time of the operation and therefore little shock; (3) there is little dissection of the periosteum from the fracture fragments; (4) danger of infection is minimized because of the smaller wound. (5) The probability of union of the fracture is increased because the pins hold the fragments together even though some absorption of the bone ends takes place.

Kirschner wires of various diameters are well suited to the forearm bones although the larger and less flexible wires are generally preferable. Long, slender, Steinmann pins are also useful in the ulna because such wires and pins produce little trauma to the bone marrow and are unlikely to cause fat embolism. (Figs. 1 to 5).

In preparation for such an operation the patient is placed on his back on the operating table with the forearm held across the chest. A tourniquet about the upper half of the arm provides a bloodless field and simplifies the procedure. After the skin is sterilized drapes and towels are fastened about the middle of the arm and over the wrist and hand thus leaving the olecranon in view. The towel about the wrist and hand is bound with sterile gauze bandage so the hand can be manipulated during the operation. After the incision the usual aseptic precautions are observed by draping the skin edges with towels or a stockinette before any dissection takes place in the subcutaneous tissues. A small incision about 1½ to 2 inches long is made over the site of each fracture and the soft tissues are separated bluntly to the bone. Any loose strands of soft tissue between the bone ends are dissected free and removed. In fractures of the shaft of the

FIG. 2. F. M. L., a male, ten years of age. A, oblique fractures of the shafts of the radius and ulna with over-riding and displacement. Fragments had been manipulated on two occasions without achieving successful reduction. B, postoperative roentgenogram showing satisfactory replacement of radius and ulna and fixation with curved Kirschner wires.

ulna the proximal fragment is lifted into the wound with a bone clamp and a wire or pin is drilled through it until it penetrates the end of the olecranon and the end of the wire is opposite the fracture. The proximal fragment is again placed opposite the distal fragment and manipulated until normal alignment is gained. The end of the wire or pin at the fracture line is then pushed back with pliers into the medullary cavity of the distal fragment. After it is driven into the distal fragment for 2 or 3 inches the end projecting from the olecranon is cut off with about ½ inch projecting from the skin. If desired, the end of the wire may be cut flush with the skin so that there is no projection. When this is done, however, there is danger that the wire may "migrate" so that it cannot be removed later.

In fractures of the proximal end of the ulna with displacement of the head of the radius it is preferable to use a Steinmann pin rather than a wire since this provides more rigid lateral support and prevents angulation. The head of the radius can then be manipulated into its normal position without danger of dislodging the ulnar fracture. In fractures of the middle of the shaft of the ulna a long wire is generally sufficient, particularly if the distal end engages the cancellous bone in the end of the ulna. In fractures of the distal third of the ulna there is generally some tear of the radioulnar ligament at the wrist. A long Steinmann pin provides adequate support in such cases while subsequent manipulation of the hand into ulnar deviation restores the normal relationship between the lower end of the radius and the ulna. The ulna is essentially a straight bone so any type of rigid wire or pin is suitable
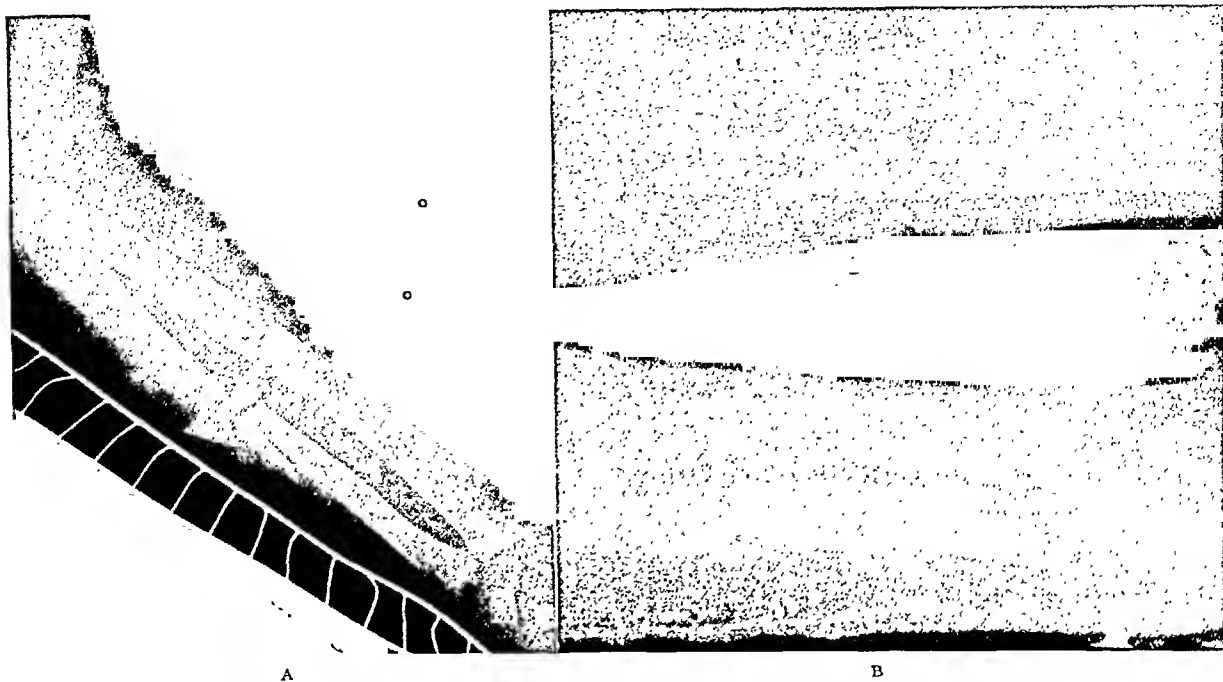
FIG. 3. J. L. B., a female, thirty-six years of age. A, comminuted fracture of the shaft of the ulna, fracture of the olecranon and fracture of the head of the radius with displacement. B, postoperative roentgenogram showing fixation of the fractured olecranon and ulnar shaft with single Kirschner wire. Radial head was removed at the time of the open reduction of the ulnar fractures.

because sufficient purchase is gained on the distal fragment. The wire or pin prevents angulation and displacement of the fragments while the cast applied after operations prevents rotation of the forearm. When both the radius and ulna are fractured, it is technically better to reduce the ulna first and secure it with the intramedullary wire before reduction of the radius is attempted. Intramedullary wires in the ulna are generally left in place for six to eight weeks after which they can be easily extracted with pliers.

In reducing fractures of the shaft of the radius it must be borne in mind that the radius is a curved bone and that this curved position must be restored in order to preserve the normal interosseous space and rotation of the forearm. Therefore, since the radius is curved, a long straight wire or pin cannot be inserted from one end of the bone to the other as in the ulna. An incision is made over the fracture of the shaft of the radius as was described for fractures of the ulna. In this case, however, the incision is extended about 2 inches on one side of the fracture in order to provide

a site for insertion of the wire into the medullary cavity. In fractures of the proximal half of the shaft of the radius the incision is extended distally in order to insert the wire from the distal fragment. In fractures of the distal half of the radius the incision is extended proximally in order to insert the wire from the proximal fragment. The soft tissues are dissected to expose the fracture line and the fragments are levered into normal relation to each other. About 2 inches proximal or distal to the fracture a large hole is drilled obliquely through the cortex into the medullary cavity. It is important that this hole should be $\frac{1}{8}$ or $\frac{3}{16}$ inches in diameter in order to facilitate the insertion of the wire. A stout Kirschner wire is "sprung" with the fingers to form an arc. The blunt end of the curved wire is then inserted through the oblique hole in the cortex and with pliers or a light mallet it is forced through the medullary cavity to the point of the fracture. Fragments are then held in normal relationship to each other with a bone clamp and the wire is pushed into the opposite fragment. The curve in the wire

FIG. 4. F. M. D., a female, thirty years of age. A, fracture of the upper third of the shaft of the ulna which was inadequately secured with short plate and screws with resulting non-union. B, post-operative roentgenogram after fracture was exposed, bone plate removed, bone ends freshened and cortical bone graft applied. Fragments immobilized in good position with single Kirschner wire.
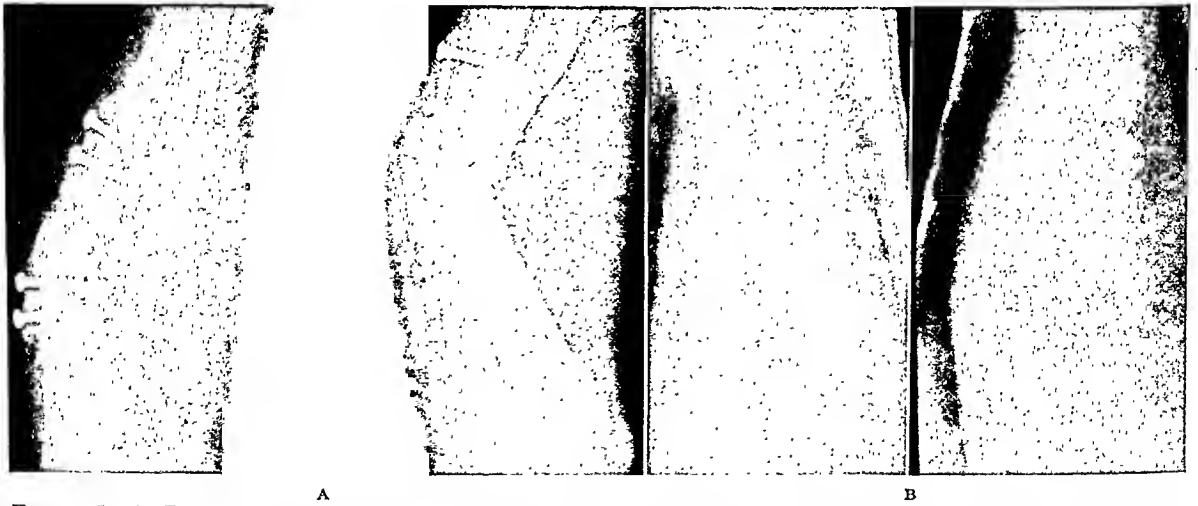
FIG. 5. L. J. D., a male, twenty-five years of age. A, old fracture of both bones of the forearm with non-union. Previous cortical bone graft to each bone with development of second non-union. B, Postoperative roentgenogram showing forearm bones held in perfect position by single Kirschner wire in the ulna. Former bone grafts removed from each bone, ends freshened and new grafts applied. Screw fixation of graft to radius. (In subsequent cases curved Kirschner wire was found more suitable for immobilization of the radius.)

provides a secure grasp on the fragments so that it does not need to project into the medullary canal of either fragment more than 2 or 3 inches. The end of the wire which projects from the wound is cut off about ½ inch from the skin and the wound is closed about it. It is not advisable to bend the end of the wire so that it can be covered with the skin for in so doing the fragments may be moved out of position or the ends of the bones may be fractured.

When there are several fractures in the shaft of the radius or ulna, the wires can be "threaded" through the fragments like a string through beads. If there is extensive comminution at the site of the fracture, the loose fragments are moulded about the wire and held in place by the soft tissues which are sutured over them. After the wires are in place in the radius and ulna and the projecting ends are trimmed, the wounds are closed and covered with light dressings. A plaster cast is then applied from the base of the fingers to the shoulder with the elbow flexed 90 degrees to prevent rotation of the forearm. The wrist is supported in dorsiflexion and in cases of ligamentous tears at the wrist the hand is held in ulnar deviation. In Monteggia fractures it is necessary to immobilize the elbow in acute flexion in order to retain the head of the radius in its proper position. The cast is worn six to eight weeks, depending upon the age of the patient and the degree of comminution of the fracture. At the end of that time the cast is removed, the wires are withdrawn and roentgenologic examinations are made to determine the progress of healing. The forearm may also be grasped to test the union by determining the amount of resistance to bending. If the fractures are not solidly healed or if they do not resist bending, another similar cast is applied for an additional month.

In nineteen cases in which we have treated fractures of the shaft of the bones of the forearm by the use of intramedullary wires and pins we have had only two failures. One patient was an epileptic who,

while wearing the cast, suffered several very severe falls which caused non-union of the ulna. The other failure was in one of the earlier patients in whom the wire in the radius was not inserted properly in the distal fragment. In general when the fragments were well reduced, the wires provided perfect fixation with a minimum of interference with bony union. However, solid bony union was seldom present in less than three months.

Intramedullary wires or pins probably should not be used in compound fractures because of the danger of introducing infection into the marrow cavity of the bones. In old fractures with malunion or nonunion wires are useful for supporting bone ends after osteotomy and bone graft operations. In any case in which a cast is applied from the fingers to the shoulder for two or three months it is important to advise the patient of the need for constant exercise of the shoulder and of the fingers. If this is not done, the long fixation may result in some permanent stiffness or pain in the shoulder. Stiffness of the fingers may also follow unless the thumb is left free in the cast to permit normal grasping exercises of the hand.

Our experience with this method of fixation of fractures of the forearm covers several years and convinces us that it offers a better chance of union and less danger of infection or non-union than any of the previous methods of operative treatment. It is comparatively simple and the results have been far better than they were following other standard procedures.

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FRACTURES OF THE NECK OF THE ASTRAGALUS

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FRACTURES of the ankle region are of frequent occurrence in general practice as far as the tibia and fibula are concerned. To a much lesser extent fractures of the os calcis are encountered. On occasion, severe injuries of the foot are seen in which both the talus and os calcis are involved, but it is quite uncommon to have a fracture of the astragalus only.[4] When only the astragalus is injured, the most common site is in the neck.[6] These fractures, on the whole, constitute a serious type of injury because of the frequency of either a partial or complete dislocation of one or more fragments, usually the body. The high incidence of some type of dislocation is attributed to the fact that the astragalus has no muscular attachments and that three-fifths of its total surface area is articular in nature.[2]

Disabling sequelae are frequent following injury to the talus due to its position as a component of one of the major weight-bearing joints of the body. The complications subsequent to accurate reduction usually result from poor blood supply and poor healing of cartilage in general. The blood supply is dependent on numerous small vessels as it has been shown that there are no major nutrient vessels.[10] It is at once apparent that an avascular or aseptic necrosis is easily possible and, indeed, it does occur all too frequently, subsequent to dislocation or after open reduction. The second major disability is a resultant arthritis due to an overgrowth of callus or the absorption of bone underlying a portion of the articular surface. The pain may be so severe and prolonged that it can be relieved only by a fusion of the joint involved.

Treatment of such fractures is dependent on the degree of displacement and may readily be classified under four general groups:

1. Fractures of the neck without displacement are simply and satisfactorily treated by plaster immobilization extending from the metatarsal-phalangeal joints to the tibial tubercle with the foot at a right angle for a period of ten to twelve weeks.

2. Fractures with impaction, but no dislocation, present a difficult problem; reduction, although occasionally successful by a closed method, more often requires operative intervention. Sawyer[8] in 1930 reported three cases of impacted fractures of the astragalus and recommended in case of second degree impaction use of an osteotome inserted into the neck and rotated until the normal relations of the astragaloscaphoid joint were restored. However, when a satisfactory reduction is not obtained either by a closed or open procedure, an early arthrodesis as recommended by Miller and Baker[6] should be done.

3. Fractures with partial dislocation of the body involve the subtalar joint, a fact which is often overlooked in the process of reduction. A satisfactory position may often be obtained by a closed procedure and offers a much better prognosis than open intervention. Under spinal anesthesia, because of the need of as much muscular relaxation as possible, the foot is forcibly plantar flexed while applying traction in the axis of the tibia. The foot is then rotated laterally and medially to break up any impaction present. Pressure is then applied by the operator to the lateral and medial aspects of the astragalus while the assistant slowly dorsiflexes the foot to a right angle. X-rays are then taken to check the reduction; if it is incom-

plete, the procedure is repeated. If satisfactory, a plaster cast is applied from the metatarsal-phalangeal joints to the tibial tubercle with the foot at a right angle. This was the procedure carried out in two of the presented cases with complete maintenance of position which is in agreement with Montgomery[7] who states that if accurate reduction is obtained, the position can be maintained with the foot immobilized at a right angle.

Special emphasis, according to Watson-Jones,[11] should be placed upon accurate reposition of the subtalar joint which may be inadequately reduced even though apposition of the fractured surfaces of the astragalus appear excellent. In cases in which this is in evidence placing the foot in plantar flexion may correct the remaining dislocation of the joint. If this is done, the cast should be changed in two or three weeks at which time the equinus is corrected.

If closed reduction is impossible, immediate open reduction is indicated because of early degeneration which may occur. Bonnin[2] believes that after forty-eight hours results are bad and he advocates reduction as soon as possible. The technic of exposing the site of fracture is well stated by Campbell.[3] Internal fixation of one type or another may be indicated to maintain reduction.

4. Fractures with complete dislocation of the body of the talus are a most serious problem. Closed reduction is practically impossible and early surgery is indicated. Unfortunately, injuries of this type are frequently associated with marked soft tissue damage, such as abrasions, contusions or avulsion. When open reduction is done, it may be necessary to make incisions, both anteriorly and posteriorly, according to Miller and Baker,[6] removing the displaced fragment through the posterior incision and replacing it through the anterior incision. This was required in the case of this type presented herein. Results of treatment are often poor when only reduction is done. Many authors [5,9] recommend that if reduction is impossible, a fusion of one type or another of the ankle joint should be done. Blair[1] in 1943 reported excellent results in two cases in which he fused the tibia and the undisturbed neck of the astragalus by means of an anterior sliding tibial bone graft after removing the fragmented body.

The question of astragalectomy in fractures of the astragalus is controversial. It is true that fusion of the ankle is not always a simple or a successful procedure, but when successful it does offer a fixed condition in which deformity should not increase. Astragalectomy offers a simple procedure, but a greater shortening of the extremity is combined with the possibilities of further deformity developing.[1] Furthermore, a fusion is free of painful movement whereas astragalectomy may require later fusion for deformity and pain. As a consequence it would appear logical to arthrodese this fracture if, primarily, a satisfactory reduction is impossible or if evidence of avascular necrosis appears following successful closed or open reduction.

CASE REPORTS

CASE I. A white male aged thirty-two injured his right ankle on November 8, 1943, when the roof of a dugout upon which he was standing collapsed. X-ray demonstrated a simple complete fracture of the neck of the astragalus, without displacement. (Fig. 1.) A plaster cast was applied; on January 15 the cast was removed. (Fig. 2.) Examination on March 27th demonstrated full motion of the ankle in all directions and the patient was free from symptoms; he was returned to full duty.

CASE II. A white male aged twenty-one injured his left ankle on October 5, 1944, when his rifle accidentally discharged; the bullet passed through the medial border of the tibia at the level of the internal malleolus and out the center of the plantar surface of the foot. (Fig. 3.) Three hours after injury a débridement was done under general anesthesia. Several small bone fragments and pieces of leather were removed from the bullet tract. A thorough irrigation with Dakin's solution was followed by insertion of a Dakin tube

FIGS. 1 and 2. Case I. January 8, 1943, simple fracture of the neck without displacement; January 15, 1944, satisfactory union.

FIGS. 3 and 4. Case II. October 5, 1944, comminuted fracture of the neck of the astragalus. December 1, 1944, union in satisfactory position.
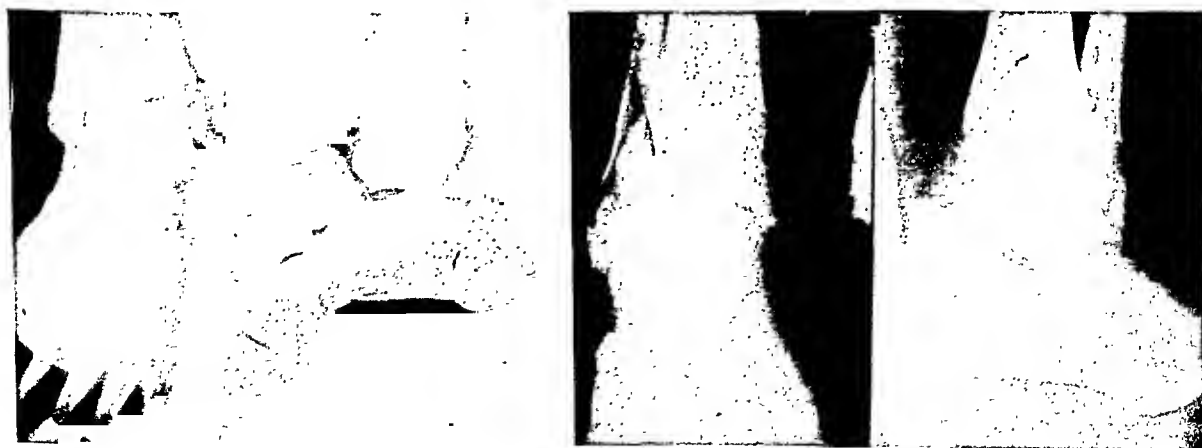
FIGS. 5 and 6. Case III. April 22, 1944, complete fracture of the neck with partial dislocation of the body. June 17, 1944, satisfactory position and union.

FIGS. 7 and 8. Case IV. August 25, 1945, complete fracture of the neck with partial displacement of the body; September 8, 1945, satisfactory position and alignment.

FIGS. 9 and 10. Case V. Complete fracture of the neck with posterior dislocation, complete, of the body; aseptic necrosis following open reduction.

Fig. 11. Case V. Position after complete astragalectomy.

through the point of exit up into the tract. Vaseline gauze was then packed around the tube and a plaster cast was applied up to the tibial tubercle. Injections of penicillin were given twice daily through the tube and therapeutic doses of sulfadiazine were given by mouth for five days. On October 18, 1944, the cast was removed and all wounds were found healed. The final cast was removed on December 1, 1944, at which time there was good union. The patient returned to duty on January 1, 1945. (Fig. 4.)

CASE III. A white male aged twenty-seven injured his right ankle on April 21, 1944. While playing basketball, he jumped into the air for the ball and landed on the ball of his foot. Roentgenologic examination revealed a simple complete fracture of the neck of the right astragalus, with partial dislocation of the body. (Fig. 5.) On April 22, 1944, a closed reduction was performed and a plaster cast was applied holding the foot at a right angle. On April 25, 1944, a walking caliper was applied. On June 17, 1944, the cast was removed and physiotherapy was started. (Fig. 6.) The

patient returned to full duty on August 24, 1944, with no complaints or disability.

CASE IV. A white male aged eighteen injured his left ankle August 25, 1945, when he slipped and fell down on embankment for a distance of 6 feet, twisting his left foot. X-ray revealed a simple complete fracture of the neck of the left astragalus, with partial displacement of the body. (Fig. 7.) On August 26, 1945, a closed reduction was performed and a plaster cast was applied up to the tibial tubercle, holding the foot at a right angle. Postreduction swelling necessitated splitting the cast anteriorly. On September 7, 1945, a new cast was applied. X-rays taken at this time revealed maintenance of reduction. (Fig. 8.)

CASE V. A white male aged twenty-five sustained a fracture of the neck of the astragalus with complete displacement of the body. (Fig. 9.) Closed reduction was unsuccessful and open reduction was performed. The body of the astragalus was removed through a posterior medial incision with replacement through an incision on the dorsum of the foot. (Fig. 10.) Non-union and osteomyelitis occurred together with an aseptic necrosis of the body. Complete astragalectomy was done. The wound healed but subsequently a sinus with purulent drainage manifested itself. A small sequestrum was later extruded and the wound healed. Spontaneous fusion with the foot in slight equinus resulted, with shortening of the extremity but complete freedom from pain. (Fig. 11.)

CONCLUSION

1. Fractures of the neck of the astragalus with or without displacement often may be treated successfully by closed methods.

2. Early adequate reduction whether by closed or open method is essential.

3. In cases in which reduction is unsuccessful or an aseptic necrosis occurs a fusion of some type is indicated.

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USE OF A QUATERNARY AMMONIUM COMPOUND FOR THE SURGICAL SCRUB*

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SINCE the time of Semmelweis and Oliver Wendell Holmes surgeons have been interested in perfecting a method for cleansing their hands. Under the influence of the philosophies of Lister the ideal goal has become the complete and lasting sterilization of the skin, both of the patient and of the hands of the surgical team. To approach this goal a multiplicity of cleansing and antiseptic agents[43] has been employed and the ritual of the surgical scrub has become deeply entrenched in the lore of the art. It was recognized early that this ritual was significantly ineffective. Since Bloodgood first began to wear rubber gloves in Halsted's clinic, the gown and glove have remained the sartorial trademark of the surgeon. Recently Lovell[32] scientifically demonstrated what many have long suspected, that by the use of surface agents perfection in the sterilization of skin (as in everything else) is impossible and must remain, as it always has been, a goal and a standard for relative comparison.

Because of intrinsic defects in existing methods of analysis, however, the relative merits of various scrub routines remained in the arena of mysticism until Price[42] in 1938 published his multiple basin quantitative technic for evaluating the bacteriologic status of the skin of the hands. In this important study he elaborated standard curves for the soap and water scrub (± 50 per cent reduction in bacteria for each six minutes of scrubbing), demonstrated the merit of 70 per cent (by weight) ethyl alcohol (± 50 per cent reduction for each minute of immersion), noted the relative inefficiency of other commonly used agents, and measured the rate of increase in skin organisms under rubber gloves (the number approximately doubling every forty minutes). Thus, the beginnings of order were spread over the chaos on the canvas of skin cleansing. This method has become standard for the evaluation of degerminating agents.

It is possible that the usual scrubbing ritual has merits as a teaching technic and a self-imposed discipline which exceed its value as a cleansing maneuver. The honest adherence to prolonged scrubbing by the clock emphasizes to the student the significance of asepsis and serves as a constant reminder to the surgeon of the importance of preserving one of the basic corner stones of his technic. On the other hand, in spite of this function as watch dog of the surgical conscience, it would seem that a scrub routine which possesses increased efficiency in degermation both in extent and uniformity of result and at the same time effects a saving in time would have real merit both to the patient and to the doctor.

Within recent years new antiseptic agents have been developed which appear to be highly bactericidal in low concentration, are relatively non-toxic and possess desirable detergent action. Domagk[11] was the first to call attention to this antiseptic quality in a quaternary amine (alkyl dimethyl benzyl ammonium chloride). Many such substances exist which have been collectively termed the quaternary ammonium compounds. They act antibacterially as cationic detergents and represent a well defined group of agents whose action on bacteria is distinct from dyes,

oxidizing agents and the heavy metal compounds. Because of their hydrophilic-hydrophobic structure they exhibit remarkable surface activity[1,11,12,41,47] making them good wetting and detergent agents; and although high surface tension depression appears related to antiseptic action,[41] it does not parallel bactericidal activity within a given series.[44]

Specific antibacterial activity has been found in high dilutions with several types of these cationic detergents, especially those quaternary ammonium compounds containing aromatic or alkyl-phenyl radicals, aliphatic radicals or heterocyclic nitrogen.[35] The relation between chemical structure and bactericidal activity has been investigated[44,49] and the most effective length of the long chain was found to be lauryl, myristyl or cetyl. Octyl substituted phenyl compounds seemed most effective with the diisobutyl grouping. Clear understanding of the relationship between structure and activity has not yet been achieved.[25,54]

Two separate actions appear to be involved in this bactericidal effect, for there is apparently both inhibition of metabolism[2,25,36] and cytolytic damage.[2,25,26,47] This action is thought to be due to the combination of the cation of the antiseptic with an essential anion in the bacterium forming a non-ionized complex.[1,25,41] It has been suggested these vital anions may be the nucleic acids.[3] The speed of this action may be enhanced because of the hydrophilic and lipophilic propreties which promote high tissue penetrating capacity. Dilutions as low as 1 gamma per cc. (one part in a million) may be bacteriostatic against viable organisms; much higher concentrations are required for bactericidal action and spores.[24]

It is to be noted that soaps fall into the group of anionic detergents since in them the alkyl radicals carry a negative charge. Soaps are but poor bacterial inhibitors[6,15,51,55] and are active largely against the gram-positive organisms only.[3] Moreover, it is extremely important to realize that soaps inactivate the cationic detergents.[14,37]

Industrially, the quaternary ammonium compounds have a variety of uses depending on their properties as a wetting agent. In bacterial control they are used extensively for the cleansing of equipment in restaurants, dairies, lavatories, etc. Some hesitancy has been shown by public health officers in approving and endorsing their use for the purpose of bacterial control.[34,45] Because of their known tendency to cause agglutination of organisms, serious criticism of the standard F.D.A. method of evaluating their bactericidal activity has been raised.[34] This is a very important technical consideration and throws considerable doubt on the validity of all *in vitro* studies of the quaternary ammonium compounds. Its relation to this study is elaborated later in this report.

Several of these compounds have already been the subject of investigation in terms of their potential clinical use. A mixture of quaternary ammonium compounds containing alkyl-phenyl radicals (alkyl (C_8-C_{18}) dimethyl benzyl ammonium chloride)* was the first compound to receive study as a disinfectant.[11] Its disinfecting quality was found to be great even in very dilute solutions.[4,13,48,56,59] Its action has been ascribed to the formation of an invisible film which is resistant to mechanical trauma and which retains the bacteria beneath it.[37] This "film" was found to be destroyed by anionic detergents or by fifteen to thirty seconds in running tap water. Since the zephiran in this experiment was a 1 per cent aqueous solution and since it has been shown that zephiran in concentrations as low as a few parts per million are bacteriostatic, it is probable that enough of the compound remained on the hands to continue to act either as a bactericide or was washed off in the collecting basin and acted bacteriostatically. Although the concept of a mechanical "film" is open to question, this problem is a serious one in evaluating results obtained

* Zephiran.

by the Price technic. Little doubt can remain that zephiran is a strongly bactericidal agent against a broad spectrum of bacteria.[20,53] It has been tested as a hand degerming agent[18,33] in dilute aqueous' solutions and alcoholic solutions, with indeterminant results, possibly because of pitfalls in the methods used.

Another compound of the zephiran group (para-tertiary octylphenoxy ethoxy ethyl dimethyl benzylammonium chloride*) was chosen for study after a preliminary screening of over thirty compounds.[14] Using the Shippen modification of the F.D.A. in vitro test,[50] a broad range of bactericidal action was found including common pathogenic fungi.[28] It was found to be a more effective skin disinfectant than other commonly used agents although no better than iodine.[10] This study, although cleverly performed, is open to question because in the use of contact agar plates against the variously prepared skin surfaces adequate amounts of the phemerol to be bacteriostatic may have been transferred to the plates. Moreover, the skin areas were first washed with soap, water and alcohol, and enough soap may have remained on the skin to neutralize the phemerol partially. Using a new and ingenious in vivo test, phemerol in 1:500 tincture was found to be more effective than other agents but less effective than 2 per cent iodine[38] against known strains of pneumococcus and streptococcus. It is unfortunate that the agent was not tested in greater strengths. The method has the disadvantage that action against only "transient" bacteria is studied. The cytologic toxicity of phemerol in comparable bactericidal units was found to be low and compared favorably with other agents although in this test penicillin was superior.[22] This low toxicity was confirmed, its use as a skin disinfectant was studied by the swab technic with favorable results and its effect in dilute solutions in open contaminated wounds was observed.[26] The compound is effective against Eschericia histolytica and

* Phemerol.

Trichomonas vaginalis.[29,52] The use of phemerol in conjunction with promanide has been suggested for tuberculous empyema.[27] This combining of a wetting agent with a known disinfectant to enhance its action, as originally suggested by Petroff,[40] has opened a field which is filled with conflicting data[9,17,39] but which may hold promise for the future. Since the cationic detergents have intrinsic bactericidal action, their use with other agents may prove synergistic.

Cetylpyridinium,* a quaternary ammonium compound containing heterocyclic nitrogen with a single alkyl radical, has also been rather extensively studied and was found to be bactericidal in low concentrations.[7,8,19,46,49] It has a low toxicity to tissue cells.[57,58] Its action as a skin disinfectant was tested[21,23,30,31] but the method (swab) in all of these studies is open to question.

Cetyltrimethyl ammonium bromide,† a quaternary ammonium compound containing only alkyl radicals, has been shown to be more effective in low concentration than soap, alcohol or tincture of iodine.[1] Its use has been advocated for impetigo[16] and for skin disinfection.[5,60]

In summary of this literature we may say that certain quaternary ammonium compounds have been found to be highly bactericidal in high dilutions in vitro. They possess in addition wetting, detergent, emulsifying and emollient properties. Their use clinically as skin degerming agents has been investigated but many of the procedures used in these investigations have not been, in our opinion, sufficiently critical. Moreover, the strength of the solutions tested clinically does not appear to be optimal. It is the purpose of this communication, therefore, to ascertain if these agents are effective as skin degerming agents for use by the surgeon for preoperative cleansing of the hands and, if so, by what method and in what concentrations.

* Ceepryn.
† Cetab.

PRELIMINARY STUDIES

As has been stated, sufficient evidence exists that the majority of quaternary ammonium compounds exert bactericidal action. Two factors appear to be operative: one, bacterial inhibition and, second, an actual killing of organisms. In a separate study[24] the bactericidal and bacteriostatic effects of these compounds has been confirmed with respect to certain pathogenic bacteria living in artificial environments. It has been noted in this laboratory that concentrations needed for lethal action were not necessarily those required for inhibition of growth and that different concentrations were required to induce such effects in different organisms. These preliminary studies were necessary for determining the range of concentration of the quaternary ammonium compound to be used in the surgical scrub.

Another consideration was the effect of the quaternary ammonium compound on bacterial spores since these often play a rôle in the infectious process. It was observed that a higher concentration was required to inhibit or kill spores. In some instances the spores were inhibited for a period of weeks and then spontaneously became proliferating bacteria. To inhibit such a process concentrations of 2 per cent or more of the specific quaternary agent had to be used.

One of the disturbing factors in the evaluation of quaternary ammonium compounds is the fact that at certain concentrations or over a period of contact this agent tends to agglutinate organisms. Thus, a certain concentration may take several hours to accomplish this phenomenon. This effect may introduce a source of error in interpretive colony counts.[34] If, for instance, several thousand viable organisms are agglutinated, they would yield only one colony in the culture medium. Thus, the colonies on a plate count might represent not the growth from a few organisms as isolated units but from many agglutinated bodies.

Agglutination may be regarded as a

naturally occurring surface tension effect of the agent on the organisms and usually occurs when the two are brought together. In thirty minutes different concentrations of hyamine* induced varying degrees of
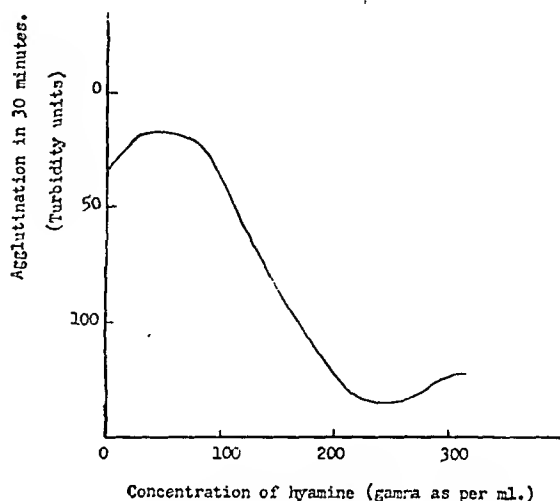
Fig. 1. Relation of concentration of hyamine to degree of agglutination at thirty minutes.

agglutination against Escherichia coli. (Fig. 1.)

Since the bacterial counts obtained from the surgical scrub were determined by the plate counting method, a source of error might be anticipated if these colonies were the result of many organisms agglutinated in masses. The same experiment noted above was performed using 3 per cent hyamine. In order to obviate any extrinsic cause for turbidity the study on 3 per cent hyamine was carried out in series using direct microscopic observation. At this concentration no agglutination was observed against Escherichia coli in forty minutes. Following this period agglutination occurs in varying degrees. Therefore, on the basis of this observation it would seem likely that the colonies obtained following the scrub were not the result of agglutinated masses of organisms. Since the bacterial flora of the surface of the hands is mixed, the hands were washed

* Hyamine 1622 (Rohm and Haas), p-diisobutyl phenoxy-ethoxy ethyl dimethyl ammonium chloride, also called Teramine (West Disinfecting Co.), and apparently the same as phemerol although the chemical formulas are stated differently.

both with water and the 3 per cent quaternary ammonium compound solution and the organisms observed for a period of sixty minutes. Thus, the mixed flora did not agglutinate during this period with the concentration of the agent used.

We believe it is safe to say, therefore, that in all of the experiments in this study done without gloves, agglutination of organisms could have played no rôle in the results since the time of contact (never more than five minutes) was too short for this effect to have occurred. Even in the longer glove experiments, we believe that this factor had negligible effect on the results.

Because of the use of quaternary ammonium compounds in concentrations higher than those which have been previously recommended, it was considered desirable to investigate the problem of toxicity. The oral administration of hyamine to mice and dogs does not produce particularly significant toxic manifestations (Rohm and Haas report) and LD_{50} is in the neighborhood of 500 mg. per kg. On the other hand, the mouse does not tolerate intraperitoneal or intravenous administration of this agent. Death occurs when it is given intravenously at approximately 1 mg. per kg. and intraperitoneally at approximately 3 mg. per kg.

The intravenous tolerance of the dog is somewhat higher. In one dog in which an aqueous solution of 5 per cent hyamine was used, 7 mg. per kg. administered intravenously was tolerated without symptoms. In another animal 15 mg. per kg. was tolerated although symptoms of ataxia and prostration were observed. The animal, however, recovered. In a third animal a dose of 27 mg. per kg. produced coma and death. Thus, the dose tolerated intravenously by the dog would appear to be between 7 and 15 mg. per kg.

Intraperitoneally the dog tolerated 100 mg. per kg. although it suffered from vomiting, malaise and blood-stained diarrhea; recovery was spontaneous. It would appear to be inconceivable that doses of this amount could be carried by the gloves of the surgeon into the abdominal cavity of a patient. However, it is worth while noting that it is undesirable to spill 3 per cent hyamine solution into the free peritoneal cavity.

There is apparently no significant absorption from granulating wounds. In two animals constant wet soaks of 3 per cent aqueous hyamine were kept over a granulating area 7.5 cm. square for a period of five days. No toxicity was noted and there was no inhibition of the healing. The granulating area remained quite clean.

It would seem, therefore, that although in very high doses hyamine was toxic when given intravenously or when poured into the free peritoneal cavity, there is adequate margin of safety in its every day use in the operating room. There appears to be no particular danger of abnormal absorption through granulating wounds.

EXPERIMENTAL METHOD

A modification of the method of Price[42] was used. The subjects were third and fourth year medical students, approximately sixty individuals participating one or more times in the experiments. There was, of course, considerable individual variation in the manner in which these subjects executed the scrubs. We consider this important in the evaluation of the results of any such experiment; because if consistent results can be obtained under these conditions, it speaks highly for the effectiveness of the agents used irrespective of the mechanical efficiency of the user.

All equipment, i.e., pipettes, petri dishes, brushes, basins, towels, gloves, etc., were sterilized by autoclaving prior to the experiment. The experiments were all performed in the same operating room under relatively similar conditions. Air contamination of the basins was checked at first and found to be a negligible factor. Thereafter no air control basins were used.

The initial bacterial flora on the hands was obtained by a specified type of brush scrub extending up to the wrists for exactly

one minute in a basin containing 1 L. of sterile water. The second step was to scrub the hands for a prescribed time in the solutions to be tested. In the experiments on soap and in the last series of tests of the quaternary ammonium compound the scrubs were performed over a sink using running water, obtaining the degerming agent from a standard soap dispenser. If a soak was to be used, it was entered immediately on conclusion of the scrub. The hands were then dried on a sterile towel and evaluation of the remaining bacterial flora was obtained by scrubbing for exactly one minute in each of a series of basins containing 1 L. of sterile water. A new sterile brush was used for each basin.

Whenever the quaternary ammonium salt was being used, and as a control in some of the soap experiments, the subject preceded the final series of basins by a one minute scrub in a basin containing 1 L. of 0.5 per cent Savol.* This step is extremely important because the soap neutralizes the action of any of the quaternary which may remain on the hands so that none will be carried into the evaluation basins. If this is allowed to happen, even minute amounts will act bacteriostatically and the bacterial counts will be erroneous (too low). Moreover, if as has been suggested[37] a film has been formed by the quaternary, this soap scrub will destroy the film and allow the true count to be obtained.

When gloves were to be used, the subject entered a sterile gown after his scrub and then put on the gloves, using sterile technic, whether wet or dry. He then pursued his usual activities around the hospital, no attempt being made to keep the outside of the gloves sterile. He returned for terminal bacterial counts at the end of a two-hour period.

No skin reactions were observed by any of the subjects participating in this experiment. However, when the quaternary was used under rubber gloves, many individuals volunteered amazement at the lack of hand sweating which they experienced

* A commercial anionic detergent.

during the two-hour period the gloves were worn. It was frequently observed that the hands appeared quite dry when the terminal counts were made in spite of active use of the hands during this period.

The bacterial counts were obtained in the following fashion: Three separate 1 cc. samples of the water were obtained after vigorous stirring with a sterile pipette immediately following the use of a rinsing basin. Each sample was mixed with 10 cc. of nutrient agar and then poured into a petri dish. Colony counts were obtained after forty-eight hours' incubation at 37°C. Thus, each subject was checked by four separate basins and each basin by three separate counts.

The final count was obtained by finding the average of the three samples taken from each basin; this multiplied by 1,000 is the count for the basin: the average of the three basins, taken after the scrub, was used as the post-scrub count. The experimental results are expressed both in actual bacterial count and as percentage reduction in bacteria with the standard deviation of per cent.

It must be noted that whenever per cent reduction or the actual data reveal a value indicating a decrease in bacterial numbers, *the figure always indicates the amount of bacteria which can be recovered from the hands and nothing more.* Although the number of organisms which can be removed would appear to be a function of the number present on the skin, the figures in no direct way express the actual number of bacteria on the skin surfaces nor do they indicate, in substance, the number of organisms destroyed. *What the figures mean are the number of viable organisms which can be removed from the skin surface in a stated period of time.* If an agent reduces the number of organisms which can be obtained from the skin, it is assumed that this agent has played a rôle in reducing the number of organisms present, providing that a film is not the protective mechanism. Regardless of the efforts by others[42] to calculate the number of bacteria present

on the skin, there is no method which directly corroborates a calculated value. For practical purposes the agents used reduce the number of organisms presumably capable of infecting another surface and hence merit their use in the surgical

taken from each basin. This was particularly true when the count was high. In very low counts there was, as would be expected, a greater percentage variation. We believe that the basin counts reflect a high degree of accuracy.

TABLE I

TYPICAL SAMPLE COUNTS SHOWING THE EFFECT OF SAVOL IN COUNTERACTING THE BACTERIOSTATIC EFFECT OF RESIDUAL QUATERNARY AMMONIUM COMPOUNDS*

Subject	Initial Count	Agent Used	Savol	1st Basin	2nd Basin	3rd Basin	4th Basin	5th Basin	6th Basin
A	1,450	Hyamine 3% for 2 minutes	No	.7	3	5	5	4	5
B	720	Same	Yes	6	5.7	12	8	5	

* In this table, and in *all* other Tables, any otherwise unqualified figure represents the number of organisms in thousands; thus 1,450 means 1,450,000 organisms.

TABLE II

CONSISTENCY OF SAMPLING OBTAINED BY METHOD

Subject	Initial Basin	Scrub Agent and Time	1st Basin	2nd Basin	3rd Basin	Post-scrub Figure Used for Computations (Average Mean)
A	1st dish—5,880 2nd dish—6,120 3rd dish—6,420 Mean—6,140	Soap scrub 7 min., 70% alcohol 1 min.	1st dish—450 2nd dish—420 3rd dish—360 Mean—410	1st dish—480 2nd dish—420 3rd dish—330 Mean—410	1st dish—174 2nd dish—150 3rd dish—180 Mean—168	329
B	1st dish—9,720 2nd dish—8,620 3rd dish—8,880 Mean—9,040	Hyamine 3% 4 min., 70% alcohol 1 min., Savol .5% 1 min.	1st dish—118 2nd dish— 84 3rd dish— 90 Mean—94	1st dish—11 2nd dish—28 3rd dish— 8 Mean—17	1st dish—46 2nd dish—69 3rd dish—83 Mean—66	59

scrub to decrease the incidence of contamination. Ideally, therefore, if no bacteria will be obtained from a skin surface, even though some were present in the hair follicles, glands and interstices, the probability of contamination at that given moment would be zero. As the per cent reduction of removable bacteria approaches 100, it is presumed the general possibility of infection approaches zero.

STUDIES EVALUATING THE METHOD

In the first place, a rather surprising uniformity was found in the three samples

The variation between basins is somewhat greater. However, no pattern of variation appeared to exist (for example, a consistant increase or decrease in counts along the series of basins). It appeared that the average of three basins, therefore, gives a fair approximation of the actual organisms removable by a one-minute brush scrub in water, i.e., the basic unit of the method. Moreover, the method serves as a check against any bacteriostatic effect of residual degerming agent, for in this case there is a steady rise in the counts through the series of basins.

Table 1 is an example of this effect, and shows the necessity of the use of a soap (Savol) scrub following application of a quaternary ammonium compound before counts are made. In this case the series of basins used was enlarged to six in order to observe how far along the series bacteriostatic effect extended if Savol is not used. It can be seen that the counts do not stabilize until the fourth basin in this case (A) whereas they are relatively stable from the beginning when Savol is used (B).

It is recognized that some of the data presented in this paper lack comparative statistical significance when subjected to analysis. This is because of the small size of the samples which in most series was only five individuals. In order to determine the validity of some of the conclusions we submitted the data to statistical analysis. Where statistical significance is attached to the evidence, this is indicated in the body of the report.* The Tables give the data in both absolute numbers of bacteria and in per cent reduction. The mean per cent reduction for any series is presented together with the standard deviation.

As an example of the degree of uniformity in the data obtained by this method, two typical protocols are presented in Table 11. Many of the protocols show even less variation than these samples.

As a basis for comparison, the effectiveness of the commonly employed surgical scrub with soap† and alcohol was first

studied. Table 111 gives these results, which are essentially similar to those obtained by Price for soap alone, but indicate better performance for soap scrub followed by alcohol rinse than he observed.

TABLE III

THE EFFECT OF SOAP AND SOAP AND ALCOHOL ON THE BACTERIAL FLORA OF THE HANDS

Subject	Agent Used	Pre-scrub Count	Post-scrub Count	Reduction in Removable Organisms Per Cent	Mean Reduction, Per Cent, and Standard Deviation
1	Soap scrub for 7 min.	2,440	239	90.2	
2		6,600	1,500	77	
3		1,320	848	35.8	
4		5,400	3,270	39.5	
5		1,800	1,300	31.7	54.4 ± 21.5
6		2,940	873	70.7	
7		6,600	3,173	52	
8		2,100	853	59.4	
9		6,240	4,134	33.8	
1	Soap scrub for 7 min., 70% alcohol rinse for 1 min.	2,613	29.7	98.9	
2		19,280	2,645	86.4	
3		1,170	182	84.5	91.8 ± 6.1
4		6,140	329	94.7	
5		704	40	94.4	
1	Soap scrub for 7 min., 70% alcohol rinse 1 min. .5% Savol scrub 1 min.	2,000	427	79.7	
2		1,394	29	97.9	
3		1,290	98	92.4	90.7 ± 8.2
4		5,950	94	98.5	
5		3,180	482	84.8	

It would appear from Table 111 that surgical scrubs using soap alone or soap and alcohol present a rather high standard deviation. This would suggest that the results of these technics are quite variable and in a considerable percentage of instances the scrub, therefore, is ineffective.

When the hands are scrubbed in a basin containing 3 per cent solution of hyamine, the uniformity in reduction of bacteria is considerably improved; Table 1v gives these results.

It can be seen from Table 1v that 3 per cent aqueous hyamine appears to be effective in reducing the bacterial flora of the hands. It is recognized that the Table does not demonstrate a statistically significant difference between a one-minute and a four-minute scrub. We may say, however, that a one- to four-minute scrub in a basin containing a 3 per cent hyamine is both an

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* To evaluate the statistical significance of a difference between two mean values, a critical ratio was determined using the following formula:

$$C. R. \text{ (Critical Ratio)} = \frac{\text{Difference in means}}{\pm \sqrt{\frac{(S.D._1)^2}{N_1} + \frac{(S.D._2)^2}{N_2}}}$$

If C. R. is less than 2, the different is *not significant* since it might occur by chance more often than 1 time in 20.

If C. R. is between 2 and 3, the difference *is significant* since the result might occur by chance less often than one time in 20.

If C. R. is over 3, the difference is *highly significant* since the result might occur by chance less often than one time in 370.

† A commercial product known as Septisol.

efficient and a relatively uniform procedure for the surgical preparation of the hands, that it is significantly better than a soap scrub and that efficiency increases with increasing time of contact.

hyamine when utilized in this fashion. The regular operating room soap dispensers were thoroughly cleaned and filled with hyamine. The subjects scrubbed with a brush in running water exactly as if they

TABLE IV

EFFECT OF SCRUBBING IN A BASIN OF 3 PER CENT AQUEOUS HYAMINE ON THE BACTERIAL FLORA OF THE HANDS—VARIATION BY TIME OF CONTACT

Subject	Agent	Savol	Pre-scrub Count	Post-scrub Count	Reduction (Per Cent)	Mean Reduction, Per Cent, and Standard Deviation
1	3% aqueous hyamine for 1 min.	1 min. in .5% Savol	1,040	3.4	99.7	
2			930	18	98.1	
3			360	2	99.4	95.3 ± 8.55
4			9,070	59	99.3	
5			334	70	80.0	
6	3% aqueous hyamine for 2 min.	1 min. in .5% Savol	2,680	3.4	99.0	
7			660	19	97.2	
8			274	15.6	94.3	96.7 ± 2.18
9			850	45	94.7	
10			820	11.8	98.6	
11	3% aqueous hyamine for 3 min.	1 min. in .5% Savol	2,040	69	96.7	
12			3,480	11.7	99.7	
13			2,830	55.8	98.1	97.7 ± 1.24
14			2,450	76.3	96.9	
15			2,460	72	97.1	
16	3% aqueous hyamine for 4 min.	1 min. in .5% Savol	950	8.9	99.1	
17			2,160	1.7	99.9	
18			630	6.1	99.1	99.1 ± 0.86
19			1,910	6	99.7	
20			980	23.3	97.7	

Since in most hospitals any fluid soapy solution used for scrubbing the hands is delivered by a soap dispenser, we wished to evaluate the effectiveness of 3 per cent

TABLE V

EFFECT OF SCRUBBING IN RUNNING WATER USING 3 PER CENT AQUEOUS HYAMINE FROM A SOAP DISPENSER

Subject	Agent	Pre-scrub Count	Post-scrub Count	Reduction Per Cent	Mean Reduction, Per Cent, and Standard Deviation
1	Scrub in running water for 4 min. using 3% aqueous hyamine from dispenser; dry with sterile towel; 1 min. ½% Savol rinse	9,647	242	97.5	
2		3,293	50	98.5	
3		440	65	98.6	97.5 ± 1.82
4		1,500	6	99.6	
5		308	21	93.2	

had been using the customary anionic soap. Table V gives the data on this experiment which appear to indicate that using hyamine from the dispenser is approximately as effective as scrubbing in hyamine in a basin.

From the data obtained to this point it appeared that 3 per cent hyamine was a practical and effective agent to use for the preparation of the surgeon's hands. We wished now to establish the optimum technic which would be uniformly acceptable for use in operating rooms generally. Does hyamine exert a lasting bacteriostatic effect when rubber gloves are worn? Will an alcohol rinse enhance or diminish its value? What is to be expected if wet or dry glove technic is used? The first step was to compare the results of a simple one-

minute soak in 3 per cent aqueous hyamine with a similar immersion in 70 per cent (by weight) ethyl alcohol. Table VI gives this comparison. It appears that both solutions have a relatively high effectiveness in per cent reduction, but that the hyamine seems to result in a lower mean post-soak count and is considerably more consistent. In this experiment we found 70 per cent ethyl alcohol to be more effective than was reported by Price.

The relative merits of a hyamine scrub, a hyamine scrub plus a one-minute alcohol soak, a hyamine scrub plus a one-minute hyamine soak, all followed by dry gloves worn for two hours, and a hyamine scrub

TABLE VI

COMPARISON OF THE BACTERICIDAL EFFECT OF A ONE MINUTE SOAK IN 70 PER CENT ALCOHOL AND IN 3 PER CENT AQUEOUS HYAMINE

Subject	Agent	Pre-soak Count	Post-soak Count	Reduction (Per Cent)	Mean Pre-soak Count	Mean Post-soak Count	Mean Reduction, Per Cent, and Standard Deviation
1	One min. soak in 70% ethyl	8,414	2,604	96.9			
2	alcohol; dry with sterile	486	138	71.7			
3	towel; 1 min. ½% Savol	450	6	98.7	3,599	443.8	85.5 ± 12.3
4		3,200	378	87.6			
5		5,448	1,433	74.9			
6	One min. soak in 3% aqueous	1,370	131	90.5			
7	hyamine; dry with sterile	404	44	89.1			
8	towel; 1 min. ½% Savol	2,308	238	89.7	1,170	128.6	89.4 ± 1.75
9		1,660	220	86.7			
10		108	10	91.2			

TABLE VII

EFFECT OF 3 PER CENT HYAMINE SCRUB AFTER TWO HOURS WEARING RUBBER GLOVES

Subject	Technic	Pre-scrub Count	Post-scrub Count	Reduction (Per Cent)	Mean Pre-scrub Count	Mean Post-scrub Count	Mean Reduction, Per Cent, and Standard Deviation
1	Scrub in 3% aqueous hyamine	559	51	90.8			
2	for 5 min., dry gloves for 2	2,910	87	96.4			
3	hr.	680	17	97.7	1,189	40.2	95.9 ± 2.0
4		666	22	96.8			
5		1,130	24	97.9			
6	Scrub in 3% aqueous hyamine	3,600	70	98.1			
7	for 4 min., 70% alcohol soak	3,480	107	97			
8	for 1 min., dry gloves for 2	5,620	59	99	2,819	64.4	96.3 ± 2.4
9	hr.	432	28	93.7			
10		962	58	94			
11	Scrub in 3% aqueous hyamine	890	3	99.7			
12	for 4 min., 3% aqueous hy-	11,600	12	99.9			
13	amine soak for 1 min., dry	7,120	159	97.8	4,411	47.0	98.3 ± 1.7
14	gloves for 2 hr.	713	32	95.6			
15		1,724	29	98.4			
16	Scrub in 3% aqueous hyamine	992	10	99			
17	for 5 min., wet glove tech-	3,900	5	99.9			
18	nic worn 2 hr.	17,780	25	99.8	6,863	10.8	99.6 ± 0.38
19		4,780	3	99.9			

followed by two hours of gloves using wet glove technic are demonstrated in Table VII. All of these procedures appear to be highly effective and consistent.

The differences in the results in Table VII statistically show in a very significant

compound throughout leading to dry gloves. (Although the best method is the wet glove technic, it was thought that few surgeons would wish to adapt a technic which is unfamiliar and uncomfortable to the majority.) Accordingly, a larger series

TABLE VIII

EFFECT OF SOAP AND WATER SCRUB WITH ALCOHOL SOAK AFTER TWO HOURS WITH GLOVES

Subject	Technic	Pre-scrub Count	Post-scrub Count	Reduction (Per Cent)	Mean Pre-scrub Count	Mean Post-scrub Count	Mean Reduction, Per Cent, and Standard Deviation
1		8,400	146	98.3			
2		5,000	372	92.6			
3		2,170	158	94.2			
4	7 min. scrub soap and water;	4,880	76	98.5			
5	1 min. soak 99% isopropyl	5,170	206	96.0			
6	alcohol; dry gloves ½%	3,080	163	94.7			
7	Savol	310	50	85.3			
8		966	102	89.5			
9		4,380	37	98.2			
10		3,000	88	97.4	2,765	98.2	96.4 ± 3.7
11		4,240	201	95.3			
12		1,420	26	98.2			
13		557	42	92.3			
14		2,360	39	98.4			
15		1,370	29	97.9			
16		1,580	47	97.0			
17		2,317	25	98.3			
18		2,310	42	98.3			
19		356	6	98.3			
20		1,440	110	92.4			

fashion (C.R. = 4) that the most effective method is the use of the wet glove technic. However, in most hospitals in the United States dry glove technic is preferred. Most surgeons like an alcohol soak following their scrub because in addition to its bactericidal activity it makes the hands very easy to dry before donning the powdered glove. From the data here presented the use of the quaternary ammonium compound followed by an alcohol rinse would appear to be quite satisfactory. However, drying the hands after soaking them in the 3 per cent aqueous hyamine solution is not annoying or difficult; and since the latter seems to have a slightly better effect, we chose to evaluate more thoroughly the technic of using the quaternary ammonium

was observed and this was compared to an equal series using the standard current surgical scrub with soap and water followed by alcohol. Tables VIII and IX give these results.

The soap and water alcohol scrub proved to be more effective than we had anticipated (96.4 ± 3.7 per cent reduction). The hyamine combination, however, was more effective (98.9 ± 1.9 per cent reduction) and more consistent. The *lowest* result with hyamine was 94.3 per cent while the *lowest* with the standard scrub was 84.3 per cent. Moreover, although the average prescrub count with hyamine was slightly higher, the average post-scrub count was less than half that resulting from the standard scrub. In the last analysis the number of available

removable organisms is the best criteria to evaluate the potentialities for contamination. It would appear reasonable to say, therefore, that a four-minute scrub with 3 per cent aqueous hyamine followed by a one-minute soak in the same agent gives a

2. A study of the effectiveness of one commonly used such compound (hyamine) as a degerming agent for the surgical preparation of hands is presented.

3. The use of an aqueous solution stronger (3 per cent) than heretofore com-

TABLE IX

EFFECT OF HYAMINE SCRUB AND SOAK AFTER TWO HOURS WITH GLOVES

Sub-ject	Technic	Pre-scrub Count	Post-scrub Count	Reduction (Per Cent)	Mean Pre-scrub Count	Mean Post-scrub Count	Mean Reduction, Per Cent, and Standard Deviation
1		890	3	99.7			
2		11,600	12	99.9			
3		7,120	159	97.8			
4	4 min. scrub 3% aqueous hy-	713	32	95.5			
5	amine from dispenser; plus	1,724	29	98.4			
6	1 min. soak 3% aqueous hy-	724	13	98.3			
7	amine; dry gloves for 2 hr	2,980	6	99.8			
8	½% Savol	2,294	34	98.6			
9		717	23	96.8			
10		510	11	97.9	3,075	44.6	98.6 ± 1.9
11		1,470	84	94.3			
12		950	8	99.2			
13		3,340	40	98.8			
14		120	9	93.4			
15		1,970	4	99.8			
16		1,970	46	97.7			
17		5,080	104	97.6			
18		3,012	104	96.6			
19		4,080	81	98.0			
20		10,260	74	99.4			

greater, more consistent and more complete reduction in removable bacteria on the hands after two hours using dry glove technic than the standard soap, water and alcohol routine. The difference is statistically significant (C.R. = 2.4). This method had the additional advantage of reducing the time necessary for the surgical scrub to a total of five minutes.

SUMMARY

1. The quaternary ammonium compounds, as a group, are detergent and bactericidal in dilute aqueous solutions and are superior in both actions to anionic soaps. They offer, therefore, potential advantages for use in the surgical scrub.

monly employed is recommended. This is a foaming bactericidal detergent solution whose physical action closely simulates the common anionic soaps.

4. This solution is much more effective in reducing the bacterial flora of the hands than the standard soap scrub followed by an alcohol rinse.

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COLECTOMY*

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COLECTOMY as a means of treating a diseased colon is a relatively new procedure for it is only during the past decade that modern surgical methods have advanced enough to make the procedure safe. Although surgery of the rectum dates back to the time of Hippocrates, Celsus and Paul of Aegena[14] (who described treatment of fissures, fistulas, hemorrhoids, etc.), surgery of the colon was held in abeyance until after the dawn of the Listerian era. Morgagni, early in the eighteenth century, proposed operative treatment of cancer of the rectum but it was not until 1739 that Faget first attempted it.

Colostomy had been reported to be used by veterinarians as early as 400 B.C. In 1776 it was used by Pillore in treatment of cancer of the rectum. In 1823 Reybard resected the sigmoid flexure for carcinoma. By 1880 only ten resections had been reported and only three of these were successful. An important advance in colon surgery was the extraperitonealizing of a segment of bowel, the procedure now commonly called Mikulicz. It was reported by Block of Copenhagen in 1891. This procedure made it possible to prevent postoperative peritonitis which had prevented advances in colon surgery.

During the past ten years, because of better understanding of methods to prevent shock, improved anesthesia, chemotherapy, blood and plasma transfusions, the mortality rate in colon surgery has been lowered to the point where such surgery is now safe. Swinton and Warren[15] reported experiences at the Lahey Clinic in which the resectability rate for carcinoma of the colon and rectum had increased from 50 per cent in 1928 to 89.9 per cent in 1938, with a lowering of mortality from 36 per cent in 1928, to 10 per cent in 1938 and 3.8 per cent in the period from 1941 to 1946.

Throughout the centuries the principal indication for colon surgery was to eradicate cancer or to relieve the effects of cancer, i.e., palliation. At the present time cancer is still the most frequent and most important disease for which surgery of the colon is used. Recently, however, because of the greater safety margin, colon surgery has been used in more benign lesions.

This paper presents three cases which demonstrate three diseases in which colectomy was successfully used to eradicate the disease. They are: (1) Hirschsprung's disease; (2) congenital polyposis of the colon and (3) chronic ulcerative colitis.

HIRSCHSPRUNG'S DISEASE

Varying degrees of dilatation of the colon associated with obstruction are frequently seen. True congenital megacolon, or Hirschsprung's Disease (first described fifty years ago by Hirschsprung), is uncommon. The etiology of this congenital disease is unknown. Disturbances of the autonomic nervous system are believed a factor (as suggested by temporary benefits of sympathectomy). The origin seems to be in the intrinsic innervation of the bowel wall (plexus of Auerbach) and not in the sympathetic nervous system itself. Symptoms usually begin shortly after birth, but by the time treatment is undertaken secondary pathologic changes (hypertrophy and fibrosis of the bowel wall) have taken place. The picture is then not one of a normal bowel with marked dilatation but a hypertrophied fibrosed tube. This tube loses its contractibility and becomes greatly distended unless manually emptied from below.

These patients usually go for weeks or months without a bowel movement, but with repeated high colonic irrigations are able to empty the bowel. The continued trauma and irritations usually lead to stricture formation and to varying degrees of intestinal obstruction. One-third of the cases involve the sigmoid only[9] while 15 per cent involve the entire colon. The rectum is rarely involved. Most of these patients become frequent visitors to local clinics for emergency treatment of obstruction.

Treatment in the past has been by medical management, i.e., having the patients irrigate the colon and whenever the mass obstructs the colon to give the patient an anesthetic and manually remove the feces from the rectum. Under this regimen it was noted that after spinal anesthesia these patients occasionally had a large bowel movement. This was in accord with the theory as to the etiology of the disease, i.e., imbalances of autonomic nervous system, and lead to the practice of sympathectomy. DeTakats[9] (quoted by Grimson, et al.) believes that some megacolons have thin atrophic walls instead of hypertrophied walls, and that if spinal anesthesia fails to give beneficial results sympathectomy would be of no value. He advises a left lumbar sympathectomy.

Various new sympathecticometic drugs, methyl bromide, a parasympathetic stimulant, and syntropan, an atropine-like drug, recently have been added to medical means of treatment. It is difficult to visualize, however, how any drug or a sympathectomy could alter the fundamental pathologic condition in the gut wall or make a fibrosed gut wall contract. In the past it was recognized that such management was not satisfactory, but because of the high mortality rate associated with colectomy no other therapy was available. Sympathectomy seemed to give temporary beneficial results.

With modern improvements in operative technic, anesthesia and postoperative care, the morbidity and mortality rate for colon surgery has been lowered to where it is now lower than the results of medical management. In reviewing the literature[9] Grimson, Vandergriff and Dratz found an average mortality from medical management of 58 per cent (19 to 79 per cent), for the more severe forms of megacolon. The literature contains numerous references of megacolon treated by colectomy.[4,6,9,12,18] Since the rectum rarely is involved, it is possible to connect the terminal ileum (or proximal colon to the sigmoid), thus retaining the rectal sphincter such as the following case demonstrates.

CASE REPORTS

CASE 1. E. O., a nineteen year old white male born in Brooklyn, was admitted to the hospital December 18, 1944, and was discharged May 15, 1945. This patient had had a known case of Hirschsprung's disease since birth. He stated that he had never had the power to move his bowels, but since birth had evacuated his bowels by rectal irrigations. At the age of three he received daily rectal irrigations. At the age of four he "lost" a rectal tube in the large bowel, necessitating an abdominal operation to remove it. At the age of fourteen he was irrigated weekly. Until 1941 he was a frequent patient at various hospitals where he received many types of treatment, i.e., medicines, massage and electrical treatments. He was seen by many physicians and even chiropractors. In 1941 the patient had a right sympathectomy; the following year he had a left sympathectomy. Following these operations, he was able to pass flatus per rectum but there was no change in bowel movements.

In 1945 he joined the Merchant Marine. Prior to this he had had weekly irrigations performed by his mother. While working at sea, his irrigations were given only once a month. He ate a normal diet and seemed to get along all right with his work as long as he received irrigations once a month. Less frequent irrigations caused him to become distended with gas. Three months before his admission, because the ship he was on became winter-bound, the patient went seven weeks without a rectal irrigation. He developed marked abdominal distention and pains. He was taken to a local hospital where, under spinal anesthesia, the
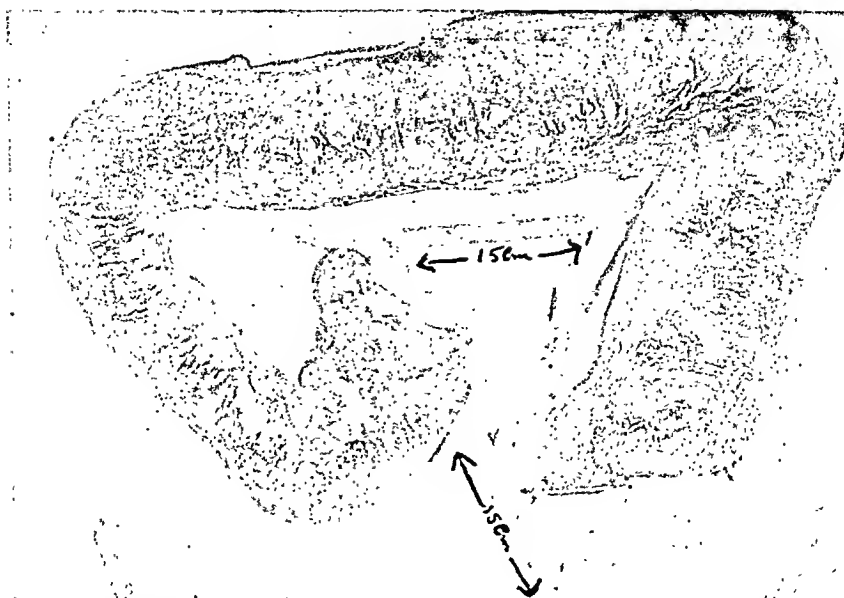
FIG. 1. Hirschsprung's disease. Photograph of a colon showing marked enlargement. It measured 32 cm. in circumference and was 190 cm. long. Histologic study revealed marked hypertrophy of the muscularis. There was no ulceration or exudation.

fecal matter was manually removed and the rectum irrigated. He apparently had some intestinal obstruction at that time.

He was transferred to another hospital but the distention was not relieved by additional irrigations and Wangensteen suction. He was then sent home. For the three weeks prior to admission to the Marine Hospital at Stapleton, N. Y. he had no solid food and apparently had been living on intravenous therapy. His admission was caused by failure to receive relief from high colonic irrigations given him by his mother.

The admission physical examination revealed an emaciated boy in moderate pain. Temperature was 100°F. and his abdomen was greatly distended. The skin over the abdomen was shiny and tense and loops of large bowel could be seen through the wall of the abdomen. There was some pain on palpation and percussion note revealed extreme gaseous distention with dullness in the flanks. Rectal examination revealed polypoid masses just within the sphincter. The sphincter was tight. Proctoscopic examination revealed an extrinsic obstruction just 6 inches inside the anus. X-ray of the abdomen revealed marked distention of the abdomen with gas. There was some increased density between the intestinal folds which was due to a slight amount of fluid or exudate.

Admission urinalysis was negative, blood serology was negative and the blood non-protein nitrogen was 50 mg. per cent. After admission he was treated with enemas and Wangensteen suction and later a Miller-Abbott tube. In about one week he was comfortable and considered able to withstand major surgery. He was prepared with sulfasuxidine for five days preoperatively as well as with parenteral vitamins and fluids.

On December 29, 1944, a colectomy was done. Through a left rectus incision the colon was completely resected down to the lower part of the sigmoid. The distal end of the ileum was closed over and a side-to-side anastomosis was performed between the ileum and sigmoid just distal to a stricture found below the promontory of the sacrum. The open end of the sigmoid was brought out through the lower end of the incision.

On gross examination the entire colon was markedly enlarged, being four or five times the normal size. An impaction was found directly over the promontory of the sacrum with a stricture formation below.

Histologic study of the 190 cm. length and 32 cm. in circumference segment of colon revealed no ulceration or exudation but there was a hypertrophic muscularis. (Fig. 1.) The colostomy began draining profusely by the fourth postoperative day and by the sixth postoperative day he was having bowel move-

ments via rectum. The distention disappeared. The discharge via colostomy became progressively less until nearly all of the fecal matter was passing by rectum. He was out of bed in twenty-one days, with marked improvement in his general condition and an 8 pound gain in weight.

On February 19, 1945 (fifty-two days after colectomy) the colostomy was closed extraperitoneally. A barium enema was done on April 3, 1945, which revealed an adequate anastomosis opening. The distal ileum was reported as being dilated and "could be mistaken for large intestines, except that the haustrations were very close together."

At the time of discharge from the hospital on May 15, 1945, five months after admission, the patient was having regular bowel movements. He was seen for a follow-up examination in June, 1948, at which time he was having daily normal bowel movements and was maintaining normal weight.

CHRONIC ULCERATIVE COLITIS

Ulcerative colitis is a chronic disease of unknown etiology, characterized by diffuse inflammatory reactions in the wall of the colon or rectum. The disease is subject to remissions and exacerbations, complicated by necrosis, ulceration and sepsis and resulting in extensive fibrotic changes in the entire wall of the large intestine. In the early textbooks[16] it was described under the heading of enterocolitis or enterotyphlocolitis and was believed to be caused by unknown bacterial infections. Later, as bacteriology and parasitology developed, certain forms were found to be due to specific enteritis, such as bacilliary dysentery, amebic dysentery, tuberculosis, actinomycosis or lymphopathia venereum.

However, a relatively large number of cases of ulcerative colitis remained that could not be classified as being due to those causes and it is these non-specific cases that we speak of as true chronic ulcerative colitis. Some authorities still claim that there is no non-specific ulcerative colitis because if a careful search is made Endamoeba histolytica or Shigella dysenteriae will be found. From a practical standpoint, however, there remains a group of cases in which no etiologic agent is found to account for the colitis.

Everyone recognizes the marked psychogenic factors present in these cases but it is always difficult to determine which comes first. By the time the disease reaches the chronic stage, with irreversible changes in the gut wall, there is ample organic reason for psychiatric disorders. These cases vary in clinical characteristics from mild rectal disorders to severe fulminating toxic diseases leading to death. Two forms are recognized, i.e., an active form and an inactive or burnt-out disease. In both forms symptoms may vary from symptomless to complete invalidism.

In the active form inflammatory changes in the colon wall are progressive; in the inactive form the disease remains quiescent, but symptoms may be present if histologic changes in the bowel wall cause alteration of the physiology of the colon. It is this inactive type of case in which the surgeon is especially interested. As the colon experiences repeated attacks of infection and ulceration followed by healing and scarring the colon loses its original histologic characteristic and becomes a firm non-elastic tube, full of fibrosis and infection. The colon is then unable to perform its function and becomes a useless tube in which chronic infection has its source.

It is apparent then that the diagnosis of chronic ulcerative colitis is made by exclusion. The differential diagnosis should include: (1) Cancer of the rectum or colon. Cancer occurs in the older age group and has a shorter history (it occurs in those over forty years of age while ulcerated colitis commonly starts in the early twenties). (2) Bacilliary or amebic dysentery usually is more acute but can occur like chronic ulcerative colitis. (3) Tuberculous enterocolitis involves the terminal ileum and is more frequently associated with pulmonary tuberculosis. (4) Lymphogranuloma inguinalae involves the rectum. It is a granulomatous lesion and gives a positive Frei test. (5) Regional ileitis

involves the terminal ileum and gives a negative proctoscopic examination.

The characteristic symptoms of chronic ulcerative colitis are rectal discharge of bloody mucus and pus, with diarrhea and tenesmus. There are associated systemic symptoms caused by malnutrition, anemia and sepsis. The disease runs a long course, lasting for years and characterized by periods of recurrence and exacerbations.

Diagnosis is established by proctosigmoidoscopy and x-ray examinations. The mucosa of the rectosigmoid shows edema, scarring and small mucosal hemorrhages, with exudation from the mucosa producing the bloody mucous discharge. The changes are diffuse so that no areas of normal mucosa can be seen in the involved segment. This is in contrast to amebic dysentery in which normal mucous membrane is found between ulcers. When seen by x-ray, the extent of the diseased colon can be determined. The fibrosis of the bowel wall produces permanent narrowing, shortening and rigidity of the colon. Loss of haustral markings, loss of flexibility, narrowing of the lumen and coarsening of the mucosal pattern are changes produced by ulcerative colitis that can be demonstrated by x-ray.

Treatment of ulcerative colitis is principally medical until the disease has progressed to such an extent that the pathologic changes in the bowel wall are likely to become irreversible.

The surgical treatment of ulcerative colitis can be divided into three categories:

1. Emergency treatment—In acute exacerbation of ulcerative colitis the patient may develop such a degree of sepsis and emaciation that the involved organ must be put at rest without too much surgical shock. This is done by simple ileostomy. It can be done as the first stage of a colectomy.

2. Curative treatment, i.e., colectomy— When the involved organ is so diseased that it no longer performs its physiologic function, it becomes a means for the body to dissipate its strength, leading to anemia,

malnutrition, avitaminosis, sepsis and even death. When healing of the infected and scarred wall can no longer take place, the only treatment possible is to excise the diseased organ. If this is done, the body is able to compensate by having the terminal ileum take over the function of the colon.

3. Treatment of malignancies—The third indication for surgery in ulcerative colitis is the development of cancer in the involved organ. Increasing attention must be focused on this complication of ulcerative colitis for it seems to be more common than previously reported.[3] Possibly more ulcerative colitis patients are now living long enough to develop this late complication.

The very nature of ulcerative colitis predisposes to malignant changes because repeated infections followed by attempts at healing, with production of polyps and scars, are some of the recognized factors that leads to production of malignant growths.

CASE II. S. O., a forty-two year old white male, was first admitted to the Stapleton Marine Hospital on May 27, 1944, complaining of severe diarrhea of six weeks' duration. He was having nine to eighteen stools daily containing pus and blood. He had a 15 pound weight loss and was unable to continue with his work as a seaman. Past history and family history were non-contributory to his present disease.

Physical examination on admission was negative except for emaciation, fever and slight tenderness over the lower abdomen. Sigmoidoscopy revealed moderate congestion and areas of patchy adherent fibrinous material in the sigmoid. Barium enema revealed marked spasticity and irregularity of the sigmoid and descending colon. Irregularities also were noted in the hepatic flexure.

Under a medical regimen fever, diarrhea, and abdominal pains continued. An ileostomy was done on July 24, 1944, at which time it was noted that the entire colon and sigmoid was thickened and its serosa inflamed. The patient continued to drain blood and pus from the rectum and failed to gain any weight. His colon was irrigated daily using saline. The ulcerated areas seen in the sigmoid failed to

FIG. 2. Right side of colon in a case of chronic ulcerative colitis. Examination revealed longitudinal ridges of grey granulation in the mucosa. The remaining areas were studded with pinhead-sized polypi. The wall was 0.3 to 0.5 cm. thick and the serosa showed areas of puckering. Upon microscopic examination massive infiltration of mononuclear cells was noted in the mucosa and submucosa. The epithelium was partly eroded, but other areas were hyperplastic and showed hyperplastic papillae.

improve. On October 8, 1945, fourteen months after ileostomy, the right half of the colon, a portion of the transverse colon and the terminal ileum were excised. Examination of this colon showed longitudinal ridges of grey granulations in the mucosa and the remaining areas were studded with pinhead-sized polypi. (Fig 2.) The wall was 0.3 to 0.5 cm. thick and the serosa showed areas of puckering.

On microscopic examination massive mononuclear infiltration of mucosa and submucosa and many germ centers were noted. The epithelium was partly eroded but other foci were very thick and formed hyperplastic papillae. The eroded zones were covered with fibrin and pus and the bases were infiltrated with lymphocytes, plasma cells and erythrocytes. Fibroblastic repair was noted.

Two months later (December 3, 1945), the remaining colon was excised down to the lower sigmoid. The excised colon again showed an edematous wall diffusely infiltrated with plasma cells, eosinophils and lymphocytes. There was considerable fibrosis in the submucosa. The patient withstood these operations very well; however, he continued to drain a small amount of pus from the rectum and was unable to regain weight.

He returned to the hospital in July, 1946, two

years after onset of the disease, and the remaining sigmoid and rectum was removed by an abdominoperineal resection. This segment of bowel showed the greatly thickened fibrotic wall with numerous small polypi present. This patient has made gradual improvement and after his last examination in October, 1947 he was able to return to his occupation as a seaman.

DIFFUSE POLYPOSIS OF COLON

Polyposis, polypoidosis, multiple adenomatosis or multiple polypoid disease of the colon was first described in 1863 by Virchow.[19] It is a relatively rare disease as shown by the fact that up to 1942 only 331 cases had been reported in the literature. Mayo and Wakefield, as quoted by McLaughlan,[11] reported that 4 per cent of the patients examined in the proctological section of the Mayo Clinic had one or more polyps but only 0.04 per cent had disseminated polyposis. It is seen not infrequently in autopsy of patients who have died of carcinoma of the colon or rectum (33 per cent of cases).[2]

The classification of Erdman and Morris[7] usually is accepted. They divided cases of polyposis into two classes:

1. Adult or acquired type, occurring in middle or late adult life, characterized by long history of colitis. This suggests the inflammatory basis of the disease. (In Kahler's series of chronic ulcerative colitis 10 per cent had polyposis.)[11]

2. Adolescent (congenital) type occurring in individuals in youth or young adult life. In these cases there usually is a distinct familial history, a hereditary disease first described by Harrison Cripps in 1882.[5] Later genetic studies[8] showed that it is transmitted by both sexes, attacks both sexes and appears to behave as a mendelian dominant. A peculiarity of this inheritable disease is that the polyps may not be present at birth in susceptible individuals but tend to make their appearance in childhood at puberty; (genetic mutation of somatic cells demonstrating the possible hereditary nature of cancer).

The importance of early recognition lies in the fact that with both types of polyposis of the colon the incidence of malignant degeneration is very high. Scarborough says, (quoted by McLaughlin).[11] "Probably no benign process has a higher incidence of malignant degeneration than colonic polyposis." In his collected series 50 per cent developed cancer. Hullsick reports 34.6 per cent malignant degeneration. One may consider that practically 100 per cent of patients with diffuse polyposis of the colon will develop cancer of the large bowel or rectum if they survive long enough. In the familial form this malignant transformation occurs early (at thirty to forty years of age).

Diagnosis of the disease can be made by digital rectal examination, sigmoidoscopy and x-ray studies of the colon with barium. The history usually is one of repeated attacks of bloody diarrhea, accompanied by crampy pain, anemia and wasting away; even obstruction develops as a complication.

The treatment is entirely surgical. This surgery must be early and must remove the involved colon. Medical treatment consists in general measures to improve health and as a preoperative measure. X-ray therapy has been advocated as a means of treatment. There seems to be little reason for this for, although it may give temporary relief of symptoms, it does not remove the real danger, i.e., the malignant degenerative tissue. The x-rays are supposed to knock out the lymphoid tissue of the bowel wall causing it to scar down and this frequently is followed by passage of large number of polypi by rectum. The majority of patients treated with x-ray subsequently die of cancer. There are no reported five-year cures.

The surgical approach to the disease was first reported in 1900 by Lilienthal[11] who did an ileosigmoidostomy followed by a colectomy.

In 1923 Coffey[11] first reported a case treated by permanent ileostomy, followed by complete resection of colon and rectum.

When the polypi in the rectum and rectosigmoid are not too numerous to permit their removal by fulguration through a sigmoidoscope, the operation of choice is to perform an ileosigmoidostomy followed by resection of the entire remaining colon as in the case reported here. When sigmoidoscopy reveals the presence of innumerable polypi, the only possible treatment that will save the patient from multiple cancers of the colon is a permanent ileostomy followed by resection of the colon and an abdominal perineal resection of the rectum and sigmoid.

It is apparent, therefore, that repeated proctosigmoidoscopy is essential in any case in which the rectum is left intact. Until recently the morbidity and mortality rates of treatment of the disease have been high. In 1928 Hullsick[10] reported a 47.2 per cent mortality rate with all forms of treatment. In 1943 McLaughlin[11] reported a 6.9 per cent mortality in patients treated with resection of colon, showing the progress of surgery, anesthesia and medical care pre- and postoperatively in colon surgery.

CASE III. J. R., a forty-six year old white seaman, was admitted to this hospital on August 14, 1944, and was discharged on January 17, 1945. Past history was non-contributory; there was a strong family history of cancer. His mother died of cancer of the liver and his father died of an abdominal cancer of an unknown type. An uncle, two aunts and a grandmother had intestinal cancer. During childhood the patient was supposed to have had amebic dysentery. On admission he gave a history of "stomach trouble for 20 years." His bowels have always been loose; he has had repeated episodes of bloody diarrhea coming on every few months, with free intervals for as long as two years.

In 1935 he was diagnosed as having chronic ulcerative colitis and was put on a medical regimen and diet. In 1937, he was told he had amebic dysentery and was treated with "shots," with some improvement. In 1941 he was diagnosed as having multiple polyps of the colon and an operation was advised but the patient refused. He had mild attacks of diarrhea dur-

ing which he would become run down and lose considerable blood. The attack which finally brought him to the Marine Hospital at Stapleton had been going on for five weeks and consisted in ten to fifteen bloody stools a day. He first noticed soreness in the right and lower quadrant and later in the right upper quadrant. He had no pain or tenesmus with bowel movement.

Physical examination on admission revealed a well developed white male with tenderness over the entire abdomen, most marked in the right lower quadrant. Temperature was normal; urinalysis, negative; blood serology, negative; stool repeatedly negative for ova or parasites; red blood count, 3.01 million; hemoglobin, 9 Gm.; white blood count, 13,050, with 6 per cent polynorphonuclears.

Barium enema x-ray study on August 10, 1944, revealed no delay in passage of the barium into the colon, but there was a generalized honeycombing appearance of the distal two-thirds of the colon and a large persistent filling defect in the lower one-half of the descending colon just above the level of the ileum. The roentgenologist's impression was extensive polyposis with at least one enlarged polyp in the descending colon. Sigmoidoproctoscopic examination on August 22, 1944, and on September 5, 1944, revealed no evidence of ulceration or polyps in the terminal sigmoid or rectum.

On September 12, 1944, the abdomen was opened through a left rectus incision. The colon was resected from the right side of the transverse colon to the pelvic brim. The cut end of the transverse colon was then brought out through the upper end of the wound and the lower end of the colon was brought out through the lower end of the wound after anastomosing the lower ileum to the lower sigmoid. This gave the patient an ileosigmoidostomy, a transverse colostomy and a sigmoidostomy.

On examination the excised portion of the colon was found to be 150 cm. in length. The whole mucosa was covered by innumerable fleshy protuberances 3 to 6 mm. wide and long, having small smooth patches of mucosa between them. There were three larger nodular papillomas 2 to 4 cm. in length. There was one crateriform ulcer 2.7 cm. wide with a deep base puckering the serosa. (Fig. 3.)

On histologic study of sections of the colon
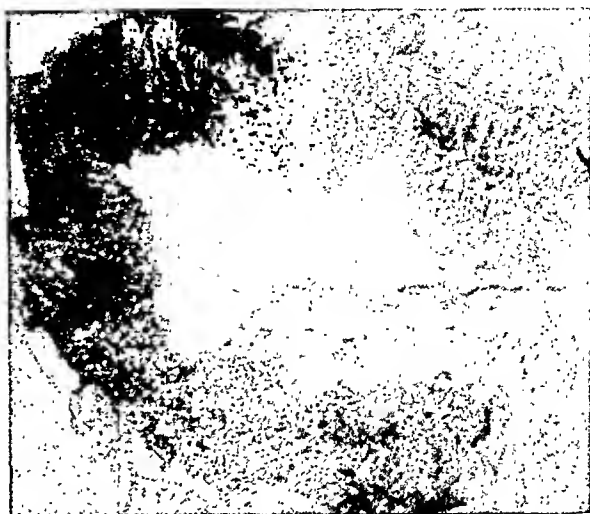
Fig. 3. Left side of the colon in a case of diffuse polyposis showing carcinomatous degeneration. The whole mucosa is covered with innumerable fleshy protuberances 3 to 6 mm. wide. There were 3 larger papillomas 2 to 4 cm. in length. There was one crateriform ulcer 2.7 cm. wide. This area had abnormal acini and infiltrative solid cords penetrating the muscularis on histologic study. The larger masses showed hyperchromatic nuclei and deficient mucus. The remainder of the tissue showed structures closely approximating the normal glandular tubules. Histologic diagnosis was papillomatosis of the colon and adenocarcinoma of the sigmoid, grade II.

the mucosal papillary structures closely approximated the normal glandular tubules except in the larger masses. Here there were hyperchromatic nuclei and deficient mucus. The ulcer had an abnormal acini and infiltrative solid cords penetrating the muscularis. No metastatic tumor was found in the lymph nodes. Histologic diagnosis was: (1) papillomatosis of the colon and (2) adenocarcinoma (grade II) of the sigmoid.

Postoperatively the patient did well. He received blood transfusions and other supportive measures. The wound healed well and at the time of his discharge from the hospital on October 25, 1944, he was having normal bowel movements and the two colostomy openings were functioning.

He was re-admitted three weeks later for a second-stage colectomy. During the time he was out of the hospital he felt much better and had no pain. The colostomy was draining, requiring six to twelve dressings a day. On November 27, 1944, through a right rectus incision the abdomen was again opened. The terminal ileum was resected just distal to the previously done ileosigmoidostomy

and the free end was closed. The remaining ileum, ascending and transverse colon were then resected. This reseeted the upper colostomy, leaving the lower eolostomy still in place.

On December 29, 1944, after sigmoidoseopy through the colostomy revealed no polyps the colostomy was closed extraperitoneally. His postoperative eourse, as happened in two previous operations, was uneventful and at the time of his discharge from the hospital on January 17, 1945, the patient was feeling well and his wounds were healed.

He has been followed periodically, the last time on August 2, 1946, when he was asymptomatic, having about three normal bowel movements per day. Barium x-ray studies of the colon taken July, 1945 revealed normally functioning enterostomy stoma, with no evidence of neoplasm.

SUMMARY

Colectomy is the chosen treatment in diffuse polyposis of the colon and Hirschsprung's disease. It is an effective means of treatment in later stages of chronic ulcerative colitis. Case reports are presented in which these diseases were successfully treated by colectomy.

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DISADVANTAGES OF DICUMAROL WITH SPECIAL REFERENCE TO THERAPEUTIC INADEQUACIES*

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THE increasing age of the surgical patient and the expanding magnitude of surgical procedures have given the complication of venous thrombosis, especially in the postoperative period, a wider field of importance. The literature of the past few years contains many excellent articles advising surgical ligation of the deep venous channels of the lower extremities while other reports extol the virtues of the anticoagulants, heparin and dicumarol. In many clinics[1-5] dicumarol is being employed as the anticoagulant of choice in the treatment of intravascular thrombosis. Its low cost and oral effectiveness have been chiefly responsible for its widespread popularity. The majority of physicians seem to prefer dicumarol to other anticoagulants although its disadvantages, such as delayed effect, necessity of daily prothrombin determinations and tendency to evoke hemorrhage have been well recognized. In this report attention will be called to several additional drawbacks to the use of this drug. For those who have had an opportunity to administer dicumarol to a large series of patients, it probably has proved to be adequate and convenient. On the other hand, many unfortunate experiences have been recorded in the literature and should serve as a warning to those unaccustomed to its limitations.

A study of our cases of thromboembolism leads us to emphasize certain other pitfalls encountered when dicumarol therapy is employed. These may be placed into four categories: (1) A standard dosage schedule is very difficult to formulate because patients display marked variability of response to the drug. (2) Not infrequently a dicumarol-induced hypoprothrombinemia, to the accepted therapeutic level, will fail to prevent thrombosis or will permit extension of an existing thrombotic process. (3) Blood transfusion and vitamin K therapy to correct a dangerous depression of plasma prothrombin by dicumarol may allow an extension of the thrombosis to occur before adequate anticoagulant therapy can be reinstituted. (4) Prothrombin determinations evaluating the degree of dicumarol effect are frequently misleading when heparin (for interim anticoagulant effect) and dicumarol are given simultaneously. This leads to inadequate dicumarol dosage.

All prothrombin determinations were performed in the hospital laboratory on diluted and undiluted plasma by the Quick method and are reported as per cent of normal in all instances.

In the general approach to the problem of thromboembolism it has been our practice to combine a strict regimen of both prophylaxis, and a search for postoperative venous thrombosis as an integral part of the routine postoperative care of all surgical patients. This includes elevation of the feet while the patient is confined to bed, leg exercises, early active ambulation, daily palpation of the calves and daily leg measurement.

THE VARIABLE RESPONSE TO DICUMAROL

Some authors[2,3,20] believe that the prothrombin level of the patient must be depressed below 30 per cent to control or to prevent intravascular thrombosis while others[4,13] maintain that a prothrombin deficiency between 30 and 60 per cent of normal is adequate. A large series of cases showing excellent results presented by

Barker and Allen[2,3] of the Mayo Clinic would indicate that acceptance of a prothrombin of 10 to 30 per cent of normal as a desirable therapeutic range is warranted.

Various attempts have been made to simplify the plan of administration of dicumarol in order to keep the prothrombin level between 10 and 30 per cent of normal. Barker and Allen suggest that the entire amount of the drug for each day be given as a single dose. They recommend that 300 mg. be given on the first day, 200 mg. the second day, and on each succeeding day that the prothrombin is not lower than 20 per cent of normal an additional 100 mg. be given; however, if the prothrombin is lower than 20 per cent of normal, no dicumarol is administered on that day.

During the year previous to this report twenty-four patients with venous thrombosis received dicumarol at the University Hospital. The earlier patients were given dicumarol according to the above outline; however, it was noted that too frequently the prothrombin level fell into the hemorrhagic zone of less than 10 per cent. Later in the series 200 mg. were given as the initial dose followed by 100 mg. or 200 mg. the following day. Throughout the entire series the patients showed a marked variability of response to the drug. One patient received 200 mg., 200 mg. and 100 mg. on successive days. In four days his prothrombin decreased from 70 to 48 per cent. A second patient received two doses of 200 mg. on successive days and exhibited only a slight depression in prothrombin from 113 to 70 per cent. In contrast, two other patients received single doses of 300 and 200 mg., respectively, and within forty-eight hours had prothrombin depressions of from 64 to 12 per cent of normal and from 61 to 15 per cent of normal. In the first group 400 and 500 mg. produced no appreciable depression. Smaller doses in two similar patients produced prothrombin deficiencies almost to the hemorrhagic zone. One young healthy adult male with a prothrombin

level of 90 per cent of normal was given 300 mg. of dicumarol. The following day the level was 25 per cent of normal and on the next day 28 per cent. One week after the initial dose there was still a prothrombin depression to 48 per cent. These patients exhibit extremes in the degree of response to dicumarol.

Barker[2] had many patients who were sensitive to dicumarol and whose plasma prothrombin level fell to less than 10 per cent of normal after 300 mg. to 500 mg. of dicumarol. Twenty-seven per cent, or 97 of 343 patients, exhibited this sensitivity.

This variability in sensitivity to the drug has been mentioned[5,13,19] by several other authors as one of its disadvantages. The individual variation of different patients is so great that a workable dosage schedule for administration is difficult to formulate. Many of the patients in whom prolongation of the prothrombin time is desirable are acutely ill. It is dangerous to spend several days in trial and error to determine the adequate maintenance dose for the individual patient.

It should be re-emphasized that there exists a marked difficulty in producing a hypoprothrombinemia in the so-called safe therapeutic range between 10 and 30 per cent of normal. This variation in response to dicumarol definitely detracts from its desirability as an anticoagulant.

FAILURE OF HYPOPROTHROMBINEMIA
IN THE ACCEPTED THERAPEUTIC RANGE
TO PREVENT THROMBOSIS

Many conditions such as fractures of the hip or pelvis, carcinoma in the lower abdomen, pelvic infections and certain blood dyscrasias, especially in the elderly patient, predispose to thrombosis.[16] There is an increasing tendency to institute some form of prophylaxis in the form of venous ligation or anticoagulant therapy to protect this type of patient. It is generally believed that a dicumarol-induced prothrombin depression to 30 per cent or less is sufficient to protect against the development of thromboembolic disease. One

patient in our series developed phlebothrombosis under such conditions. The case report follows:

CASE I. E. G., a sixty-four year old white female, was admitted with a diagnosis of carcinoma of the rectum and diverticulosis of the colon. On January 16, 1947, a one-stage abdominal perineal resection was performed. At that time her prothrombin level was 83 per cent of normal. On the following day dicumarol (200 mg.) was given and for the next three days 100 mg. were administered daily. The prothrombin level on January 20th was 80 per cent. On January 22nd and 23rd it had fallen to 15 and 14 per cent, respectively. On the evening of January 22nd the patient developed severe pain in both calves. Homan's sign was present bilaterally. The following day there was marked edema of the right calf and a rise in temperature and pulse rate. A diagnosis of bilateral phlebothrombosis of the deep femoral veins was made. The dicumarol was discontinued and heparin was administered intravenously for three days. The clinical signs completely subsided; however, it was then decided in view of the patient's age and general condition that surgical ligation was indicated. Accordingly, she was taken to the operating room and both superficial femoral veins were tied. A large thrombus was removed from the right superficial femoral vein. The patient's recovery was uneventful.

This illustrates a failure of dicumarol to prevent the development of intravascular thrombosis even during a period of sufficient hypoprothrombinemia. Two other cases receiving prophylactic therapy developed thrombosis. One of these patients who received 300 mg. of dicumarol experienced a pulmonary embolism while the prothrombin level was 36 per cent, and another who received 500 mg. of dicumarol developed a phlebothrombosis while the prothrombin was 36 per cent. Although insufficient dicumarol had been given to produce a depression in the suggested therapeutic range, the plasma prothrombin approached 30 per cent. The two cases of almost adequate therapy, in addition to the one case in which the prothrombin insufficiency was considered safe, stress the

dangers of undue faith in dicumarol as prophylaxis against intravascular clotting.

EXTENSION OF VENOUS THROMBOSIS DURING ADEQUATE ADMINISTRATION OF DICUMAROL

Twenty-four cases of phlebothrombosis were treated with dicumarol. One patient developed an extension of the intravascular thrombosis and one developed a pulmonary embolus while the prothrombin levels were less than 30 per cent of normal. Reports of these two cases follow:

CASE II. B. H., a thirty-five year old male, was admitted on June 17, 1947, with the complaint of pain in the left chest and cough of two days' duration. The clinical impression was acute fibrinous pleurisy or pulmonary infarction. On the seventh hospital day the patient developed severe pain in the left calf with edema and marked tenderness of the left leg. This was the first concrete evidence of venous thrombosis. He was started simultaneously on dicumarol and intravenous heparin. Heparin was discontinued on the second day when the plasma prothrombin level had fallen with 300 mg. of dicumarol to 22 per cent of normal and after the clinical signs of thrombosis had subsided. On the third day with a prothrombin of 20 per cent marked pain with severe tenderness was noticed in the left calf. There was increased edema of the left leg and ankle. These signs were believed to be clinical evidence of the extension of the thrombosis following cessation of heparin therapy. The prothrombin deficiency induced by dicumarol had failed to prevent an increase in the thromboembolic process. Dicumarol was discontinued and anticoagulant therapy was continued with subcutaneous heparin in gelatin.* The clinical signs of thrombosis subsided and the patient was discharged two weeks later.

CASE III. P. W., a forty-six year old male was admitted with a diagnosis of carcinoma of the bladder. On June 3, 1947, the ureters were catheterized and a biopsy of the bladder tumor was made. Fifteen days later he developed a phlebothrombosis of the right leg. Intravenous

* Heparin in gelatin (Dep-Heparin) was supplied for this study by the Upjohn Company, Kalamazoo, Michigan.

heparin therapy was given for three days. Two hundred mg. of dicumarol were given on both the second and third days. On the fourth day the prothrombin was 11 per cent and all signs of thrombosis were receding. Heparin was then discontinued. On the morning of the next (fifth day) the prothrombin level was 13 per cent. About 6:00 P.M. of that day, the patient complained of pain in the right popliteal space and in the right calf. There was a definite increase in the size of the leg and marked evidence of extension of the thrombosis. This case responded to heparin therapy; but when heparin was discontinued after dicumarol-induced hypoprothrombinemia of less than 30 per cent had been established, an extension of the thrombosis occurred. The dicumarol was discontinued, and the patient was given subcutaneous heparin in gelatin. He experienced an uneventful recovery.

In this series of twenty-four cases of dicumarol-induced hypoprothrombinemia the incidence of failure to prevent extension of the thrombotic process is 8.3 per cent. In surveying the literature for reports of similar experiences it was found that no special attention had been called to the incidence of failure although several authors[10,11,13,14,16,17,18] reported similar difficulties encountered in their series. In an attempt to compute the percentage of failures in other clinics the reports were meticulously reviewed to ascertain the adequacy of the dicumarol therapy. A tabulation of some results of previous investigations has been made. Only those cases in which the author stated that a prothrombin depression to 30 per cent or less of normal had been maintained have been included. Table 1 lists the percentage of failures occurring during so-called adequate hypoprothrombinemia in the treatment of an existing thromboembolic process.

There are many reports in the literature concerning the failure of dicumarol to prevent the development of thrombosis and pulmonary embolism; however, the depression of the plasma prothrombin in many of the cases had not been in the currently accepted therapeutic zone. In the preceding paragraphs the difficulty in maintaining adequately depressed plasma prothrombin has been emphasized. It is generally agreed that patients who do not show an adequate prothrombin depression by dicumarol may

TABLE I

Author	Year	No. Cases	Failures	Per Cent
Wright and Prandoni[18]	1942	10	1	10.0
McRoberts[11]	1942	10	1	10.0
Wasserman and Staats[13]	1943	49	3	6.1
Eckstam[14]	1944	23	1	4.4
Barker[17]	1946	572	8	1.4
O.S.U. series	1947	24	2	8.3
		678	16	2.3

develop a thrombosis or have an extension of an existing thrombosis. It is clear that the same may occur in spite of the depression of plasma prothrombin to the presently accepted therapeutic level.

THE DEVELOPMENT OF PULMONARY EMBOLISM OR EXTENSION OF THROMBOSIS AFTER TRANSFUSION FOR EXCESSIVE DEPRESSION OF PLASMA PROTHROMBIN BY DICUMAROL

One case of interest illustrates a hazard which may confront the physician who chooses dicumarol therapy.

CASE IV. P. T., a thirty-six year old white male, was operated upon September 23, 1946, for a retroperitoneal tumor (Hodgkin's granuloma). Prophylactic anticoagulant therapy was started. Twenty-four hours after operation he was given 300 mg. of dicumarol and on the following day 200 mg. of dicumarol. On the third day the prothrombin level fell to 10 per cent. Fear of hemorrhage prompted the administration of intravenous vitamin K and a fresh whole blood transfusion. In twenty-four hours the prothrombin level rose to 60 per cent. Dicumarol was readministered but before the prothrombin had again been depressed to a safe level the patient developed a non-fatal pulmonary embolus. This incident occurred thirty-six hours after dicumarol therapy was reinstituted.

The fear of hemorrhage when the pro-thrombin lies in the zone below 10 per cent of normal is apt to evoke the immediate administration of coagulant therapy which frequently elevates the prothrombin level above the safe therapeutic range. This may allow a thrombosis to form before an adequate hypoprothrombinemia can be reinduced. The use of vitamin K and whole blood transfusion, when an alarming pro-thrombin level is reached, must be judiciously considered unless hemorrhage is present for this therapy may prove a sin of commission. Whole blood will restore the prothrombin for a period of four to six hours. Its effect seems to be due to a re-placement of plasma prothrombin.[2] Intravenous vitamin K reaches a marked effect in two hours and a maximum effect in eighteen hours.[20] It is imperative that a careful watch be kept over the rising plasma prothrombin to prevent a pro-longed period during which the level is above 30 per cent. It must be remembered that should the plasma prothrombin ap-proach normal, forty-eight hours may be required before renewed dicumarol therapy will become effective and there is thus a latent danger of extension of thrombosis and pulmonary embolism during this period.

MISLEADING PLASMA PROTHROMBIN
DETERMINATIONS DURING SIMULTANEOUS
HEPARIN AND DICUMAROL THERAPY

A standard anticoagulant regimen in many clinics is to administer heparin and dicumarol for a period of two to three days until dicumarol has depressed the plasma prothrombin to the desired level. If blood is drawn too soon after the intravenous administration of heparin, the prothrombin level may appear therapeutically de-pressed. This apparently low prothrombin level in heparinized blood of patients re-ceiving dicumarol is quite misleading. By the very nature of the Quick test it seems logical that the antiprothrombin and anti-thrombin properties of heparin would influence the clot formation, which indi-cates the end point in the laboratory determination of plasma prothrombin. This seems obvious since the prothrombin test measures the coagulation time of recalcified plasma in the presence of excess thromboplastin.

Long, Hurn and Barker[21] have demon-strated the effect of heparin on the pro-thrombin time. They have shown that a high level of heparin in the blood which produces a greatly increased coagulation time considerably affects the apparent prothrombin level. We have verified this by demonstrating in several cases pro-thrombin levels of 12 and 18 per cent when the blood was drawn within an hour after an intravenous injection of heparin, and levels of 40 to 60 per cent in the same cases two to three hours later.

A simple experiment can be performed for demonstration. Blood drawn from a normal individual in a dry syringe will show a normal prothrombin level. If blood is drawn from the same individual in a heparinized syringe (1 cc. of 10 mg. of heparin is drawn into the syringe then pushed out leaving only a minute amount of heparin solution along the wall of the syringe), there will be a marked increase in the prothrombin time. Small amounts of heparin intravenously do not appreci-ably effect the prothrombin level. Our experience has been that the heparin level must be sufficient to produce a prolonga-tion of the coagulation time (Lee and White) beyond forty minutes before a marked effect on the prothrombin time is obtained.

A false sense of security is thus experi-enced when an apparent prothrombin depression to the safe therapeutic range is obtained on heparinized blood. The heparin effect will disappear in two or three hours and the true prothrombin level may be well above 30 per cent of normal. It is necessary, therefore, that blood for pro-thrombin tests be drawn at least three hours after an intravenous dose of heparin (or when the Lee and White coagulation time is below forty minutes) if an accurate

determination of the dicumarol effect is expected.

Although heparin is more expensive, it can be administered and controlled almost as economically as dicumarol if the cost of the daily prothrombin test, essential to sound dicumarol therapy, is considered. In our opinion the subcutaneous administration of heparin in a gelatin menstruum[9,10,22] requiring only infrequent, easily performed coagulation time determinations, may eventually prove to be superior.

SUMMARY

1. A study of the problem of venous thrombosis during the past year has disclosed several failures of dicumarol therapy, namely: (1) Too often the unpredictable response of the patient to dicumarol makes it very difficult to maintain the prothrombin level in the suggested therapeutic range of 10 to 30 per cent of normal. (2) Even when a prophylactic prothrombin depression has been maintained within the therapeutic range, thrombosis may occur. (3) Case studies have been presented of two patients with thrombosis in whom the thrombotic process extended in spite of a dicumarol-induced hypoprothrombinemia of less than 30 per cent of normal. (4) A transfusion of whole blood to rectify excessive depression of plasma prothrombin by dicumarol may increase the coagulability of the blood sufficiently to allow thromboembolism to occur.

2. The dicumarol effect, as evidenced by the Quick prothrombin test, may be most inaccurate if determined on blood containing moderate amounts of heparin. This is due to the effect of heparin on the end point of the test.

3. Although dicumarol has been the popular anticoagulant in this country for several years, the newer preparations of heparin in a gelatin menstruum may prove safer and more dependable.

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THE COMMON NON-VASCULAR NEVI AND THEIR TREATMENT*

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THE various forms of nevi both pigmented and non-pigmented are very common. Every individual has many; some may have hundreds of them. The following anatomic and clinical classification (Table 1) includes the majority of these lesions.

The flat pigmented spots and patches may or may not contain neval cells. When the pigment is found in patches in the basal layer of the epidermis and in the protoplasm of the dendritic cells of the reti, these pigmented spots are called epithelial nevi. A freckle is such an example. When the pigmented spots also have neval cells, they are real pigmented nevi. If they are superficial and do not contain hair, they are known as nevus spilus.

The pigment in these nevi is melanin. It is an iron-free chromoprotein, probably a metabolite of pyrocatechol. Its precursor is shown by exposing unfixed, frozen tissue to a solution of dioxyphenylalanine whereupon pigment granules become visible in

TABLE I
NON-VASCULAR NEVI

1. Benign Lesions
   A. *Flat lesions*
      (1) Pigmented spots and patches
         (a) Epithelial nevi
         †(b) Nevus spilus
   B. *Raised lesions*
      (1) Hard nevi
         ‡(a) Nevus verrucosus linearis
         (b) Hyperkeratotic nevi (congenital warts)
      (2) Soft nevi
         †(a) Nevus verrucosus (nevi covered with hard or soft papillary excrescences)
         ‡(b) Nevus papillomatosus
         (c) Fibroma pendulum
         †(d) Hairy, warty nevus
         †(e) Pigmentary nevi (soft moles including non-hairy and hairy moles, nevi pilosi, nevi sebacei)
            (1) Hairy nevi (nevus pilosi)
               (a) Small, soft, hairy nevi
               (b) Giant nevi (bathing trunk nevi)
            (2) Non-hairy nevi (black, bluish black, or brownish moles)
            (3) Fatty nevi (nevus lipomatodes)
            (4) Fleshy pedunculated nevi
            (5) Mixed types
            (6) Unusual types (blue nevi, Mongolian nevi, depigmented nevi)

II. Malignant lesions

† Those containing neval cells.
‡ May or may not contain neval cells.

the cells. This is known as the dopa reaction. Melanin is found in the protoplasm of many cells in the epidermis and in the dendritic cells of the corium. Some of these cells are capable of ameboid movement and may carry pigment to distal parts. The neval cell can produce melanin and may or may not exercise this function.

The true nevus is probably of nerve tissue origin and is a tumor of the tactile sense organ, the Meissner corpuscle. The neval cells have abundant nerve connections. The normal epidermis has numerous minute tactile organs (Merkel-Ranirer corpuscles) and non-medullated nerve fibers end in these. The Merkel-Ranirer corpuscles may account for some of the nevi which occur intra-epidermally. Another reason for supposing neval cells to be of nerve tissue origin is this ability to produce melanin. The production of melanin has long been known to be a function of nerve tissue. In lower animals it is under voluntary control as in the production of melanin in the ink sac of the cuttle fish and squid. Various lizards and fish in mimicry change their color to suit their environment.

The occurrence in neurofibromatosis of pigmented patches and pigmented nevi shows the close relationship of nerve tissue tumors to neval cell growth. Melanin formation is also under pituitary, adrenal and gonadal control. In Albright's unilateral cystic disease of bone accompanied by unilateral distribution of pigmented patches and pigmented nevi, precocious sexual development is present. Menstruation has been known to occur at two and three years of age.

In some fish the injection of the female sex hormone will cause the fish to assume color. This characteristic is made use of in a test for the detection of pregnancy. The effect of sex hormones on the production of melanin is seen in the development of pigmented nevi during adolescence and pregnancy. While pigmented nevi may be present on the skin at birth or shortly afterward, a great many do not make their recognizable appearance until after puberty. Pregnancy makes nevi darker. As a matter of fact, pregnancy has a tendency to make all pigmented patches become darker.

When the gonads are not very active, the growth potentialities of the nevi are not great; it is only when gonadal secretion is at its height that benign nevi may become malignant melanomas. While pigmented nevi are present in infancy and childhood, it is rare for malignant melanomas to develop before puberty. Malignant degeneration of benign moles occur frequently during pregnancy. At this time the melanomas grow rapidily and spread widely. That this activation is not the result of pigment formation is shown by the fact that the non-pigmented nevi are also stimulated to growth, and malignant melanomas derived from these are more malignant than those that produce melanin. The functional differentiation of the neval cell is the production of pigment. In the non-pigmented melanomas more of the energy may be exerted on cell production than on melanin production.

Other glands that play a part in melanin production besides the ovaries, testes and the pituitary body are the adrenals. In Addison's disease of the adrenal glands melanin patches are seen especially in the mouth.

At times pigmented nevi resemble clinically seborrheic warts (verruca senilis) and small patches of senile keratosis. The seborrheic warts which usually occur on the body can be rubbed or washed off without leaving bleeding points; the senile keratosis which usually occur on the exposed parts of the body will leave little bleeding points when the keratotic scales are scrapped off. The senile keratosis are usually smaller than the seborrheic warts, fewer in number and show signs of inflammatory reaction and occasionally induration. While the superficial layers of some of the verrucose nevi might be scrapped off, the base of the lesion is still present and can be identified easily. If the seborrheic warts ever become malignant, basal cell

carcinomas are apt to develop. The pre-cancerous lesion, senile keratosis, usually develops a squamous cell carcinoma, while the pigmented nevus develops a malignant melanoma.

The hard nevi group, nevus verrucosus linearis and nevus hyperkeratotic, may or may not contain neval cells. Very often they belong in the group of epithelial nevi.

Soft nevi are raised or pedunculated with a smooth or furrowed or even warty (verrucous) surface. All the soft nevi, with the possible exception of the fibromas, are characterized histopathologically by the presence of neval cells.

Pigmentary nevi vary greatly in size from those scarcely visible or pinhead in size to giant moles involving extensive portions of the body such as the bathing trunk nevi. Those which contain hair are usually congenital and those which do not may be congenital or acquired. The pigmented nevi whether recognizable at birth or appearing later in life tend when once developed to remain as such without change in size or pigmentation. When such changes occur, transition to malignant degeneration must be suspected.

The two most common types of pigmented nevi are, first, the small deeply pigmented flat type (junction type of Traub) which may or may not contain hairs and which occur especially on the extremities; secondly, the soft, smooth, slightly elevated, moderately pigmented mole which may contain hairs and which is seen especially on the face, neck, trunk, thighs, buttocks and genitalia. Both are rarely over 2 to 3 cm. in diameter. These two are also the most important because they may become malignant. (Figs. 1 to 9.)

In 30 to 60 per cent of cases malignant melanomas arise from recognizable pigmented nevi. They arise principally from the superficial, flat, junction type of nevus and the slightly elevated pigmented nevus. But they may also occur in the ordinary hairy mole although Affleck[1] in a series of 317 cases of malignant melanoma found none which occurred in hairy nevi. In 266
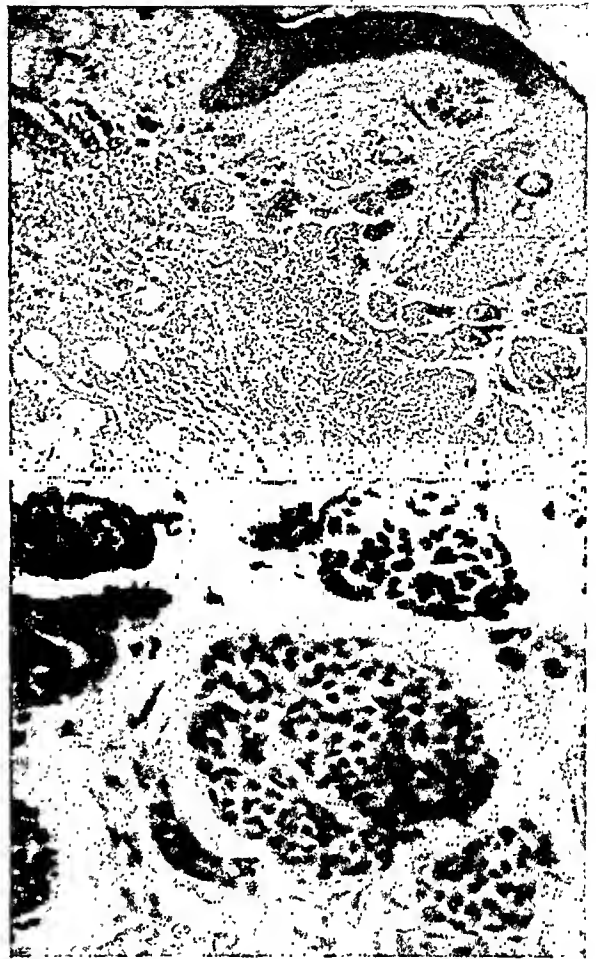
FIG. 1. Photomicrographs of a benign nevus, low and high power magnifications. Note the tightly packed, small, hyperchromatic cells. Occasionally in some soft fleshy moles the cells become atrophied and come to resemble fibrous tissue.

cases they developed from pre-existing nevi. Hazen[3] found only a very few malignant melanomas developing from hairy nevi. A great many malignant melanomas arise from non-recognizable nevi either those which are amelanotic or from nevi which are so small or obscured that the patient does not have knowledge of their presence.

While most nevi become recognizable by puberty, some of the fleshy, pedunculated nevi may have their development delayed until later in life; this is particularly true in women in whom nevi may appear about the time of the menopause. Most of these nevi remain as tiny, unpigmented tumors which the body tries to extrude through the skin. They are seen as small filiform

FIG. 2. Same case as Figure 1. The patient had numerous non-pigmented moles of her face since birth. They looked more like papillomas. They gradually grew until they reached their present size. Biopsy taken from the large lesion on the chin showed the histologic picture seen in Figure 1.

FIG. 3. Same case as Figure 1 and 2 which shows a follow-up photograph four months after electrocoagulation removal.

excresences or tags which are nearly always confused with warts. They appear mostly on the neck, chest and perineum. A great number of these pedunuculated nevi, however, may not contain neval cells. Occasionally the neval cells become atrophied and come to resemble connective tissue cells.

The blue nevus is a sharply circumscribed, smooth, round or oval, indurated papule or nodule usually varying from 2 to 15 mm. in diameter occurring most frequently on the face and hands. There usually is a history of a solitary lesion which either has been present since birth or developed in infancy or early childhood and which has remained as such without increase in size. The blue nevus is a benign lesion but following trauma and inflammation may undergo malignant change. The blue nevus is characterized histopathologically by well formed mature dermal dopa positive melanoblasts having long bipolar dendritic processes laden with melanin pigment.

The Mongolian spot is much larger than the blue nevus and occurs as an ill defined, bluish to mulberry colored or blackish plaque, usually in the vicinity of the sacrum. It is present at birth but usually disappears in the third or fourth year of life. The Mongolian spot is also characterized by the dopa positive melanoblasts.

MALIGNANT TUMORS ARISING FROM NEVI

Not all malignant tumors occurring in benign pigmented nevi are malignant melanomas. Malignancy can occur in other than neval cells and new growths can arise from the basal cells and the squamous cells of a pigmented nevus. However, the most common malignancy is the malignant melanoma.

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FIG. 4. The patient had this soft pigmented nevus since birth. It grew slightly with the years until it reached its present size. Histologically, the lesion was a benign pigmented nevus.

FIG. 5. Same case as in Figure 4 three months after electrocoagulation removal.
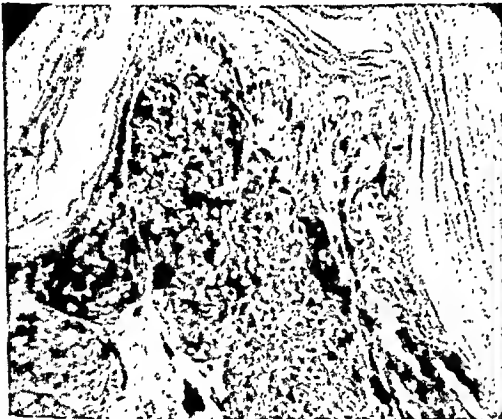
FIG. 6. Photomicrograph, low power, of a pigmented nevus. Note that the pigment is in the basal cell layer of the epidermis, in some of the cells of the corium and in many of the neval cells.
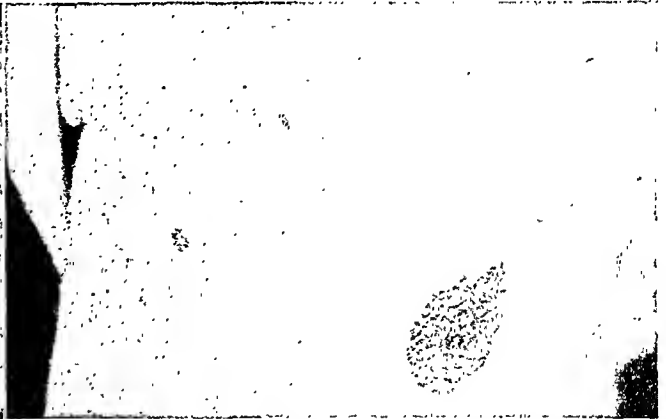
FIG. 7. Same case as Figure 6; note the numerous moles in this patient's neck. The large lesion was removed by surgery and the histologic section is seen in Figure 6.

Malignant melanomas may occur at any age from six months on; the average age of onset is fifty years. Malignant tumors of the skin are very rare among children but when they do occur they are apt to be malignant melanomas. However, Pack[4] says that before puberty malignant melanomas are not apt to metastasize. More than half of the malignancies arise from nevi that have been present at birth or shortly afterward. The nevi that appear in adult life are not of recent origin but make themselves visible at this time through increased growth and pigmentation. A great many of these also may give rise to malignant melanomas when fully developed

FIG. 8. Pigmented nevi in neurofibromatosis. Nevi appeared about the age of five in this patient. Neurofibromas were found mostly in the cervical region. The patient also had numerous bilateral cystic lesions in his bones.

FIG. 9. Same patient as in Figure 8.

or even when latent, for many malignant melanomas arise in areas where no definite nevi are present.

The occurrence of malignant melanomas is about evenly divided among male and females. They rarely occur in negroes and when they do, they are most apt to be found on the least pigmented areas, namely, the soles of the feet, oral cavity and nail mattrix.

In a series of cases reported by Pack[4] 20 per cent of the malignant melanomas were found on the head and neck, 16 per cent on the foot, 18.7 per cent on the trunk, 8.7 per cent on the leg, 10.9 per cent in the eye, 6 per cent on the hand, 6.5 per cent on the arm, 1.3 per cent on the skin of breast, 1 per cent on the male genitalia, 3 per cent on the female genitalia, 1.3 per cent within the oral cavity and 2 per cent were of undetermined origin. Drs. Butterworth and Klauder[2] in 650 cases found malignant melanomas had developed from moles located as follows: head 16.5 per cent, neck 7.7 per cent, trunk 15.5 per cent, genital and anal region 2.7 per cent and the foot 52.3 per cent. (Figs. 10 to 16.)

PROPHYLACTIC TREATMENT OF NEVI
TO PREVENT MALIGNANT DEGENERATION

The incidence of malignant degeneration of nevi is infinitesimal when the number of moles in existence is considered. However, the time elapsed between transition from a benign nevus to a malignant one is so very short (a few weeks or months) that often by the time the patient becomes aware of a change in character, metastases may already have occurred. For this reason prophylactic removal of nevi, especially the flat junctional type and slightly raised soft non-hairy lesions, should be done under any of the following conditions: Remove those that are darkly pigmented,
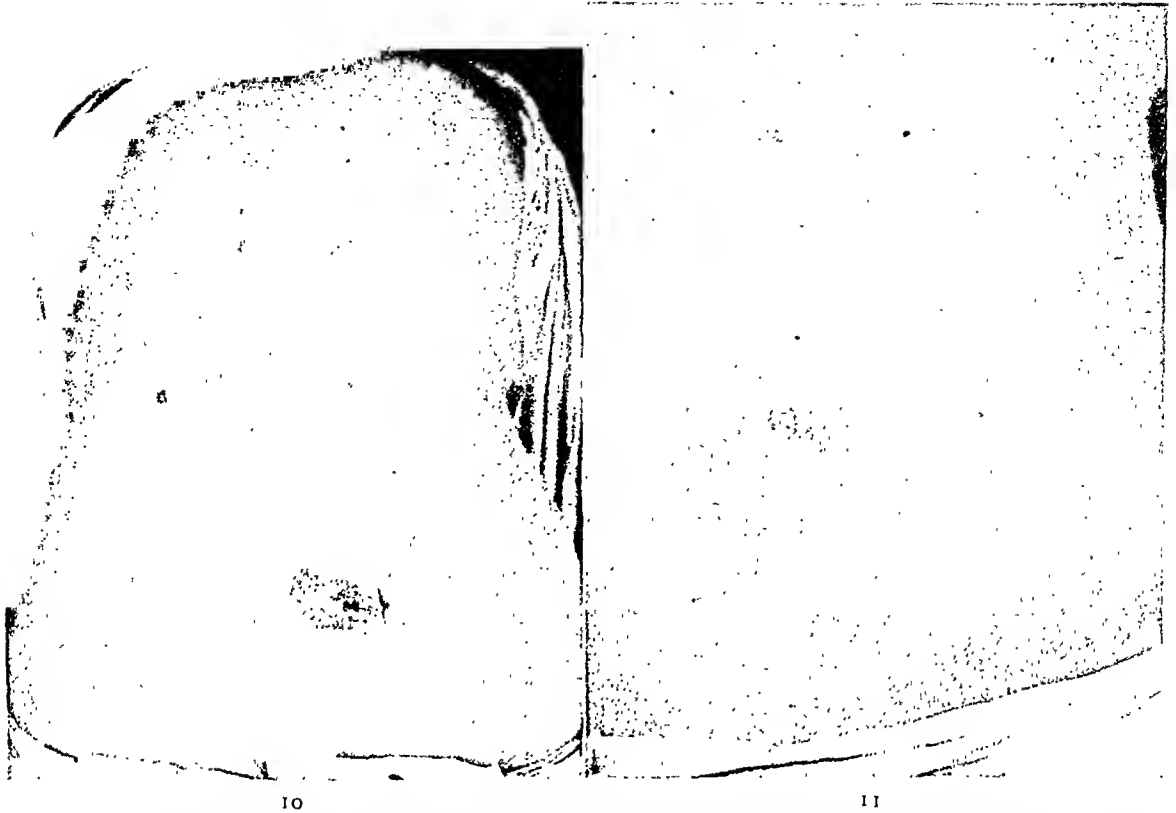
FIG. 10. Basal cell carcinoma in a pigmented nevus on the back. This patient has had this mole since birth. It gradually reached its present size. For the past six months a small, raised, ulcerative tumor occurred near the center of the pigmented patch. Biopsy showed basal cell carcinoma. The patient was diabetic and had heart disease so it was decided to try roentgen therapy.

FIG. 11. Same case as in Figure 10 three months after the lesion received 4,000 r. (200 r. 20 times) with the following factors: 200 peak kv., 0.5 mm. of copper and 1.0 mm. of aluminum filtration, 50 cm. skin focal distance and port to cover the pigmented nevus. Notice that the basal cell tumor is gone and that the pigment in the nevus is also disappearing. Pigment often disappears in pigmented nevi after both radium and roentgen therapy; however, radiation is too dangerous to use in treatment of pigmented nevi. Occasionally, pigment disappears in negroes in the areas treated by radium or roentgen rays.

either brown, black or bluish in color. Remove nevi appearing suddenly late in life or those occurring in areas subjected to trauma and irritation by clothing or occupation. Moles may be irritated by eye glasses, false teeth, collars, belts, suspenders, garters, rings and shoes. Moles on the inner sides of the thighs and legs may be irritated by horseback riding. Lesions on the hands and feet should be removed. Remove these lesions even if they are pale in color for they can give rise to the amelanotic malignant melanoma. These may be more malignant than the dark ones. Remove nevi which show increased pigmentation whether it be spotty or uniform. Remember that moles normally increase their pigmentation on exposure to sunlight, and that deepening in color during summer

does not necessarily imply early malignancy; however, severe sunburn should be avoided. Remove those nevi that show a tendency to increase in size and elevation and those that show signs of hemorrhage and infection. Remove them if they cause pain. Those moles in scars from furuncles and carbuncles should be removed. A mole should be removed as soon as possible after trauma. Occasionally melanomas may develop six to eight months after trauma; this is especially true of those on the hands and feet. Do not wait until the melanomas have developed.

Huge brown, black or bluish nevi involving wide segments of the skin should be removed in infancy and childhood when the menace of malignant degeneration is usually absent. If the lesion is too large

FIG. 12. Squamous cell carcinoma in a pigmented nevus of the nose. This patient had had a pigmented nevus of the nose since birth, but in the past four months the center showed slight elevation and ulceration. Biopsy showed squamous cell carcinoma. Roentgen ray was given to the entire pigmented area.

FIG. 13. Same case as in Figure 12 eight months after 6,000 r. (300 r. 20 times) units were given with the following factors: 200 peak kv., 0.5 mm. of copper and 1.0 mm. of aluminum filtration, 50 cm. skin focal distance and port to cover the nevus. Notice that the pigment disappeared along with the squamous cell carcinoma.

FIG. 14. Pigmented nevus, malignant melanomatous degeneration. The patient was born with a pigmented lesion on the back of her neck. This always remained about the size of a ten cent piece. Seven years ago it began to darken and become bluer. For the next five years it gradually grew larger. Two years ago she visited a doctor who applied carbon dioxide ice on the mole. She had weekly applications for one and one-half years. The area increased in size in spite of the carbon dioxide ice. About one and one-half months ago several tumor areas grew out from the black mole and bled profusely.

to remove in one stage with skin grafting, it may be done in several stages. A large ellipse of the tumor is excised from its center so that the scar of the approximated wound is a linear one running through the center of the remaining nevus. The second operation removes another ellipse with the previous scar. This can be repeated until the entire lesion is removed. While cutting through a nevus is safe before puberty, it is not safe to do this after puberty. Sufficient time is allowed between operations to permit stretching of adjacent elastic skin. In a child more stretching is possible than later in life.

The blue nevus which has deeper blue black color and a much deeper deposition of pigment than the pigmented mole is recognized as a much more dangerous lesion to handle. They are found most frequently on the face and upper extremities. However, although it is a benign lesion, when irritated to a malignancy this

tumor and the Mongol mole form true melanosarcoma which metastasizes quickly and usually to the lung; therefore, remove the benign lesions early.

METHODS OF TREATING NEVI

Pigmented macules and patches are best left alone unless they must be removed for cosmetic purposes. Under local anesthesia they may be electrocoagulated. Surgical excision by scapel and electrocautery is used on hard and soft verrucous nevi.

Both complete and incomplete removal of pigmented and nonpigmented nevi by electrocoagulation is done thousands of times without mishap. However, treating a lesion in this way, especially when the lesion is incompletely removed, a recurrence of the lesion ensues once in a while and wide metastases follows very quickly. Of course this also occasionally follows what appears to be a complete surgical

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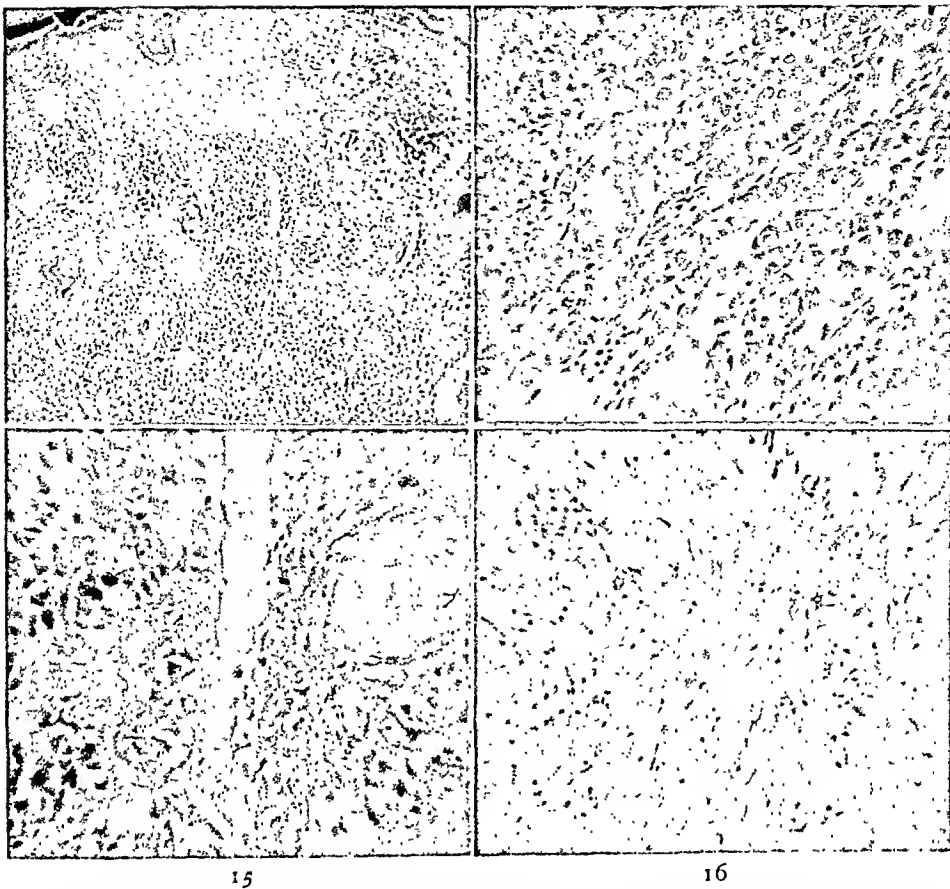
FIG. 15. Photomicrographs of histologic section of same case as in Figure 14. Low and high power magnification shows malignant melanoma. The histologic picture of the tumor masses growing from this malignant nevus was similar to that seen in Figure 16. Very little pigment was present.

FIG. 16. Photomicrograph of histologic sections of a malignant melanoma before (upper photomicrograph) and after roentgen ray treatment (lower photomicrograph). The patient had a pigmented nevus removed from her leg. It promptly recurred along with extensive metastases to her groin. Many hundred metastases also occurred along the entire extremity. Roentgen ray therapy was given only as a gesture. However, the metastases gradually disappeared. The lower photomicrograph was taken in a pigmented metastatic lesion which was beginning to dry up and disappear. Notice the lack of any melanoma cells.

excision. It is hard to say whether the incomplete electrocoagulation stimulated a benign nevus to malignancy or whether the lesion was malignant all the while and therefore recurred. However this may be, there is no question about the fact that incomplete electrocoagulation of a malignant melanoma stimulates its growth and causes it to metastasize quickly. The open wound and secondary infection flare the malignant melanoma into greater growth.

The hairy nevus can be treated effectively by electrolysis and later by removing the nevus surgically. Some say that a hairy nevus seldom shows evidences of change toward malignancy. Even so, I believe that since some may develop malignant melanoma, they all should be removed especially when they increase in size and pigmentation.

Fatty, lobulated and pedunculated nevi should be excised.

The treatment of malignant lesions occurring in pigmented nevi is primarily a surgical one. I have treated patients with both basal cell and squamous cell tumors occurring in pigmented nevi in whom surgery would cause too much disfigurement, with both roentgen and radium therapy and the results were good. The

treatment of malignant melanoma is the removal of the primary lesion and its lymph-draining area. Radiotherapy of malignant melanoma should be done on hopeless cases not because many will be benefited, but because occasionally one is radiosensitive. I have seen one such cure. In a group of 217 melanomas treated with radiation Pack[4] reported a disappearance of the primary lesion in five patients and a diminution in size in forty-seven other lesions. Thus about 2.5 per cent of these lesions are radiosensitive and disappear. Others are somewhat sensitive and become smaller.

Pack[4] found that of 267 patients with malignant melanoma treated surgically only thirty-eight or 14.7 per cent survived five years. When a primary lesion was not too far advanced, their five-year cure in a group of seventy patients was 33 per cent.

In thirty-two patients with axillary metastases in whom axillary dissection was done nineteen subsequently died, thirteen are living and well, four for over five years. In a similar series of thirty inguinal dissections twenty-four patients are dead and only six are living and well, some for five years.

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TREATMENT OF PERITONITIS WITH PARENTERAL STREPTOMYCIN AND PENICILLIN*

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DURING the past few years various chemotherapeutic agents have been used in the treatment of peritonitis. Although the sulfonamides and penicillin alone or in combination lowered the mortality, there still was considerable room for improvement. Streptomycin given alone fell short of being ideal. In recent years considerable clinical, experimental and theoretic evidence has been accumulated which indicated that a combination of penicillin and streptomycin given parenterally would be of greater benefit than any previous method of treatment. Having used parenteral penicillin and streptomycin in the treatment of peritonitis, we are anxious to report our results. A survey of some of the data on which the choice of that mode of therapy is based appears indicated before describing our experience.

Most cases of peritonitis are caused by Escherichia coli, some strains of non-hemolytic or alpha-hemolytic streptococci and Escherichia welchii, in that order of frequency. The gram-negative bacilli are notably resistant to penicillin but are sensitive to streptomycin. Farris[1] and his co-workers reported on a group of animals with experimentally induced peritonitis. Ninety per cent of the controls died. All of the animals that received a single injection of streptomycin into the lumen of the appendix at the time of operation recovered. Ninety per cent of the animals that received parenteral streptomycin survived. In other animals 40,000 units of penicillin were placed in the lumen of the appendix at the time of operation; all survived. Two out of five rabbits that received penicillin parenterally died. It was concluded that penicillin was effective in preventing toxemia and death but apparently less effective than streptomycin.

Another laboratory study was conducted by Zintel[2] and his group. They reported a series of animals in whom experimental peritonitis had been produced. The results were as follows: (1) controls, 6.6 per cent survived; (2) parenteral streptomycin alone, 27.4 per cent survived; (3) local sulfonamide plus systemic penicillin and systemic sodium sulfadiazone, 40 per cent survived; (4) streptomycin parenterally plus the group of No. 3, 60 per cent survived; (5) systemic penicillin plus systemic streptomycin, 70 per cent survived. Zintel (May 1947) quotes Nichols as stating that the combination of streptomycin and penicillin had a synergestic action against certain bacterial organisms, an action greater than the additive effect of each.

The literature on peritonitis also contains reports of clinical investigations of the sulfonamides and new antibiotics. De-Bakey[3] reviewed the Army experience with streptomycin. This survey included thirty cases of peritonitis in which the patients were treated by parenteral streptomycin. Twenty of these were of appendiceal origin. The results were as follows: twenty-four improved, three died and the rest showed no change. He concluded that streptomycin given alone does not produce dramatic results in peritonitis although its use as an adjuvant to standard surgical measures seemed justifiable. Nichols and Harrell[4] reported their experience with streptomycin in the treatment of peritonitis and concluded that "streptomycin may prove of value in some cases of peritonitis." Most

of their patients were in advanced stages and that may have accounted for the statement that "our experience has been discouraging." Streptomycin was used parenterally and alone. The National Research Council[5] in its report on streptomycin discussed fifty-three patients with peritonitis of whom thirty-nine recovered, twelve died and two showed no effect. They concluded that the results were sufficiently encouraging to advocate using streptomycin in all cases of peritonitis in which the infecting organism was a susceptable one. They believed that it might be desirable to inject streptomycin into the peritoneal cavity if the infection was generalized.

Other authors have reported on the use of penicillin either alone or in combination with a sulfonamide. Imes[6] was able to study 243 cases of peritoneal penetration caused by missels. He believed that sulfonamides and penicillin appeared to be equally effective in the treatment and prevention of peritonitis, but was not impressed by the results of their local instillation into the abdomen. Griffin[7] and his co-workers advocated a combination of parenteral penicillin and oral sulfadiazine in the treatment of acute appendicitis. They had a mortality of 1 per cent in the treatment of 108 patients. Griffin also quotes Fauley as stating that in experimental peritonitis induced by the ligation of the appendix 92.6 per cent of the dogs died. If penicillin is given at the time of the operation, none of the dogs died; but if it was delayed for twelve hours, 21 per cent of the dogs died. Thomas[10] and his group also reported good results in the treatment of generalized peritonitis with parenteral penicillin. It remained for Crile[8] to advocate large doses of penicillin given parenterally to overcome the penicillinase formed by the gram-negative bacilli. He advocated 100,000 units of penicillin intramuscularly every two hours for two to six days, followed by a reduced dose for three to four days. He reported fifty cases of peritonitis of appendiceal origin with no mortality. Although his results were good, it is now known that many gram-negative organisms are resistant to penicillin even though they do not produce penicillinase.

Other data were available that enabled us to determine the dose of the antibiotics, their mode of administration and the frequency of injections. It has been well established that streptomycin has a pronounced effect on gram-negative bacilli while penicillin has a pronounced effect on the gram-positive cocci. A combination of the two appears to be ideal theoretically. It has also been established that both drugs appear in the peritoneal cavity promptly and in levels that equal that of the blood. Murphy[9] reported some experiments in which the peritoneal levels for streptomycin at times exceed the blood levels. Maximum serum levels of streptomycin are obtained one to three hours after a single intramuscular injection with a decrease over a period of ten to twelve hours. When streptomycin is given every four hours, there is a cumulative effect. On a dose of 0.4 Gm. every four hours a maintenance blood serum level of 16 micrograms per cc. is achieved. Crile[8] states that when 100,000 units of penicillin is given every two hours a blood serum level of 1.7 units per cc. is achieved in thirty minutes. In one hour the level is 0.8 units and in two hours 0.3 units. A level of 0.02 units of penicillin per cc. is effective in the control of most penicillin sensitive organisms.

We set up the following dose schedule for our patients: Each patient received 2 Gm. of streptomycin daily given in doses of 0.4 Gm. intramuscularly every three hours for five doses. In addition, 100,000 units of penicillin were given intramuscularly every three hours. These agents were continued until signs of improvement occurred although one of our patients had to discontinue penicillin because of a severe uncontrollable urticaria. A Levin tube was inserted into the stomach and hooked up to a suction apparatus if distention, nausea or vomiting were present. The patients were given at least 3,000 cc. of fluid paren-

terally if the Levin tube was used. Usually 1,000 cc. of normal saline were given plus amigen or plasma. Occasionally small blood transfusions were administered if the patient appeared toxic. No oxygen was used except for one patient who was extremely dyspneic. No special effort was made to have the patients in Fowlers position; any comfortable position was permitted. Occasionally a rectal tube was inserted to aid abdominal deflation.

Our present series is too small to be significant statistically. Nevertheless, our results have been dramatic and it was decided to make this a preliminary report and furnish representative cases as illustrating our experience. The first patient had a perforated duodenal ulcer of long duration. This was confirmed by operation. Although the perforation was not closed, the patient made a smooth postoperative recovery.

CASE REPORTS

CASE I. This patient was admitted October 14, 1947, with a history of having had severe epigastric pain for the past twenty-four hours. The admitting physician found slight tenderness in the right upper quadrant with a suggestion of a mass in the region of the right upper rectus muscle. The patient's general condition appeared to be good. The next morning the pain had radiated to the right lower quadrant and there was marked tenderness and rigidity along the entire right side of the abdomen. There was tenderness in the right loin posteriorly.

The abdomen was explored the following morning through a McBurney incision. The appendix was normal and there was a large amount of purulent material in this area. The incision was closed and a right upper rectus incision was then made. An ulcer was found in the duodenum perforating into the pancreas. There was a large amount of purulent material in the entire operative field. The pancreas was necrotic and friable in the region of its head and the muscles along the posterior right gutter were edematous and showed hemorrhagic changes. Because of the extreme number of adhesions and the friable nature of the pancreas and duodenum, the ulcer was not freed so as

to permit closure. A drain was placed down to the site of the perforation and the wound was closed. Cultures of the pus obtained at the time of the operation were negative.

The patient was placed on routine treatment for peritonitis and given the two antibiotics in the recommended doses parentally. The drain was removed in six days. Both wounds healed nicely, the McBurney in one week and the right upper rectus incision in fifteen days. There was only slight distention of the abdomen during the first forty-eight hours. Following this, convalescence was entirely uneventful except for a slight elevation of temperature which persisted until the fourth postoperative day.

We were extremely impressed by this patient's course in view of the fact that there was a large amount of purulent material in the abdomen and a proven perforation had been found which was not closed. Nevertheless, the patient was successfully able to handle the generalized peritonitis.

CASE II. This forty-two year old white male was admitted to the hospital on September 24, 1947. About four days prior to admission the patient had developed pain in the epigastric region followed by vomiting. Several hours thereafter the entire abdomen had become painful with the maximum pain in the right upper quadrant. The pain radiated around the abdomen toward the vertebra posteriorly. There had been no bowel movement since the onset of pain. Extreme dyspnea and a nonproductive cough were also present. The temperature at the time of admission ranged between 101° and 102° F. and the pulse between 120 and 130. X-ray examination of the chest was negative. The white count was 22,100 with 89 per cent polymorphonuclears. The electrocardiogram was negative except for sinus tachycardia. The patient was critically ill and showed marked distention of the abdomen, diffuse tenderness and rigidity over the entire abdomen and diffuse tenderness along the right posterior portion of the abdomen. Oxygen was required for marked dyspnea. A diagnosis of diffuse peritonitis was made, etiology undetermined. Several men had seen this patient and their diagnoses were as follows: (1) perforated peptic ulcer; (2) empyema of the gallbladder with perforation; (3) retrocecal appendicitis with perforation.

The patient received our treatment for peritonitis but continued critically ill for two

weeks. About that time marked tenderness developed over the lower costal ribs on the right both laterally and posteriorly. The x-ray also revealed a marked elevation of the right dome of the diaphragm. On October 13, 1947, a right subhepatic abscess was found and drained. Culture of the pus at that time showed Escherichia coli. Following drainage the patient continued to have an elevated temperature for three days but improved markedly. The abdomen became soft and the abdominal tenderness and rigidity disappeared. In three days the patient became afebrile and asymptomatic. Several weeks after drainage of the subhepatic abscess a gallbladder series was done and this revealed a non-functioning gallbladder.

This patient apparently had a generalized peritonitis of four days' duration. At the time of admission his condition was critical. Under supportive therapy and treatment with antibiotics the infection localized in the right subhepatic space where it could be drained. Following this, recovery occurred.

CASE III. This patient, a twenty-nine year old white male, was admitted on October 27, 1947, with a history of having had severe right lower quadrant pain for ten days. A diagnosis of acute appendicitis was made but the patient refused to enter the hospital. Vomiting was present the first few days but this ceased at the time of admission. The patient had had several severe chills. The pain in the right lower quadrant persisted with occasional radiations down the lateral aspect of the right thigh. During the last week of his illness the patient had had no bowel movement despite repeated enemas. At the time of admission the patient was acutely ill and showed diffuse tenderness over the right lower abdomen. Marked spasm and rebound tenderness were also present in that area. The patient's temperature ranged from 100° to 103.6°F. with the pulse varying from 80 to 100. The blood count showed 18,400 white cells with 86 per cent polymorphonuclears. A few of the examiners who had seen this patient thought that there was a suggestive mass in the right lower quadrant. A diagnosis of ruptured appendix with localized peritonitis in the right lower abdomen was made. The patient received our course of supportive therapy plus the two antibiotics. On November 1st the temperature had become normal and on November 5th no mass could be felt in the right lower abdomen. On November 3rd streptomycin and penicillin were discontinued

and the patient was allowed out of bed. The remainder of his course during hospitalization was uneventful.

This patient had a localized peritonitis secondary to perforated appendix. The response to therapy was prompt and dramatic.

CASE IV. This patient, a white male thirty-one years of age, was admitted on August 4, 1947. Twenty-four hours prior to admission the patient developed abdominal pain of a rather mild nature. He vomited three times following the onset of the pain and had a temperature of about 100°F. He stated that he had had a similar episode during the past three years. He did not appear acutely or chronically ill and there was practically no tenderness on deep pressure in the right lower quadrant. The white count showed 10,800 cells with 85 per cent polymorphonuclears. The admitting physician made a tentative diagnosis of gastroenteritis. On August 6th the pain recurred and localized in the right lower quadrant. Marked tenderness was noted at this time with elevation of temperature. An appendectomy was done on August 6, 1947, and an acute gangrenous appendix with perforation was found. The operator stated that the cecum was markedly involved in the inflammatory process but there was very little generalized peritonitis reaction. The patient was placed on penicillin and streptomycin the day following operation. An infection of the wound developed postoperatively which drained pus containing Escherichia coli. The temperature ranged to 101–5°F. until August 15th, but there was never any but slight distention and the patient was able to pass gas from his rectum spontaneously. By September 3rd the wound had healed and the patient was discharged.

This is a case of a gangrenous perforated appendix treated by appendectomy. A wound infection developed but recovery occurred under our regimen of supportive therapy plus the two antibiotics. Unfortunately he received 150 mg. of streptomycin instead of the larger dose we now advocate. The larger dose may have prevented the occurrence of a draining wound.

CASE V. This patient, a white male, age twenty-four, was admitted on October 29, 1947. The day before admission he experienced pain in the epigastric area. This was followed by vomiting and radiation of the pain to the right lower quadrant. On examination there was

marked tenderness and moderate rigidity in the right lower abdomen. The appendectomy was done on October 29th and an acute suppurative appendix was found. Because of the difficulty in removing this appendix in the usual manner, the surgeon decided to do the appendectomy by the retrograde method. After ligating the base of the appendix and severing it distal to the ligature, the surgeon proceeded to work on the remaining portion of the appendix. During this procedure he noticed that fecal contents were appearing in the operative site. A search of the field revealed that the ligature which had been tied around the base of the appendix by one of the trainees had slipped off and that liquid cecal contents were appearing in the operative field. The wound in the cecum was closed in three layers but there had been moderate soiling of the peritoneal cavity before this could be accomplished. The patient was given our routine treatment for peritonitis plus parenteral doses of penicillin and streptomycin. Temperature ranged from 99° to 101°F. the following two days but was normal after that period. The pulse went up to 100 the first day but came to normal levels after that period. At no time was there any abdominal distention and the patient's general condition was very good postoperatively. The wound healed by primary union and he was discharged on November 7th.

During this study the question arose as to the dosage of streptomycin and its frequency of administration. Some of our patients received streptomycin in doses much smaller than those we now advocate or else at much longer intervals. The penicillin was administered in doses of 100,000 units every three hours but the patients received either 150 mg. of streptomycin every three hours or 0.2 Gm. every six hours. These patients did not do as well as we had hoped. Testing the organisms of each case of peritonitis for sensitivity to penicillin and streptomycin may be of aid in determining dosage.

CONCLUSION

There is clinical, laboratory and theoretic support for the combined use of parenteral streptomycin and penicillin in the treatment of peritonitis.

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TRANSTHORACIC TOTAL GASTRECTOMY FOR CARCINOMA OF THE STOMACH*

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IN the past the general attitude of surgeons toward carcinoma of the stomach was wholly pessimistic and it was generally thought that patients afflicted with this diesase were classified as hopeless. The reason for this pessimism was due to the fact that the patients did not consult the surgeon early in the disease and there was a tendency among medical men to procrastinate and treat these patients medically without realizing the consequences of lesions in the stomach. It takes careful analysis and cooperation among the patient, the practitioner and the roentgenologist to discover these cases early. Only early surgery will give a more hopeful picture in these cases in the future.

Schlatter in 1897 performed a total gastrectomy upon a patient who lived one year and fifty-three days and, subsequently, died of a recurrence. Finney and Rienhoff reported that until 1929 the mortality rate in all cases of total gastrectomy reported in the literature was 53.8 per cent. Subsequently, the mortality rate has been greatly reduced. Coller in 1943 reported a mortality of 10.5 per cent and W. P. Longmire, Jr. in 1947 reported twenty cases with a mortality of 10 per cent. In 1932 the resection rate for lesions of the stomach was 9 per cent whereas in 1939 it was 43 per cent and the mortality rate had decreased from 53.8 to 13 per cent in 1945.

It is evident, therefore, that these patients with carcinoma of the stomach do not have an entirely hopeless outlook at the present time. The reason for this is that we are resecting entire stomachs more frequently; this is made possible because of our greater knowledge of anesthesia and our greater application of surgical technic with the use of chemotherapy.

At present we lean toward complete removal of the diseased organ. To accomplish this the surgeon must be familiar with the best possible approach for each individual patient. The transthoracic approach is a relatively recent addition in handling patients with cancer of the stomach. It gives free exposure and complete visualization of the field of operation and it therefore makes it possible to accomplish radical surgical treatment.

The transthoracic approach was based on the experimental work by Mickulicz, Sauerbruch and others during the period of 1895 to 1905. Adams and Phemister used this approach in 1938 for carcinoma of the lower esophagus and cardia of the stomach. Recently great impetus toward this approach for carcinomas of the cardia and fundus of the stomach and the esophagus was due to Garlock, Phemister and Churchill and Sweet. The technical advantages of this approach are now well established and the field has been expanded to include complete removal of the stomach with esophagojejunostomy as well.

The prognosis in total gastrectomy for carcinoma of the stomach is not too hopeful. At present we have no statistics based on a five-year postoperative basis. Churchill and Sweet reported ten survivals from the operation. Two died of recurrence and the remainder have been well three months to one and one-half years after the operation. Garlock reported twenty-two cases with nine deaths, of the thirteen survivors four died of recurrence from seven to thirteen months and nine were alive for periods of three months to two and one-half years after the operation. While we have

no records as yet of five-year cures, we have at least been able to provide these patients with comfort during their survival period.

Gastrectomized patients do not react too badly to the absence of their stomach. Diarrhea is sometimes prominent and it is thought to be due to the removal of hydrochloric acid which normally has an attenuating effect on the bacterial flora of the upper gastrointestinal tract. Steatorrhorea may be present due to disturbances in fat digestion. There may be disturbances in the hemopoietic system such as secondary anemia although Waugh at the Mayo clinic reported a case of total gastrectomy which was done for a benign lesion. This patient is still alive after seven years but is now developing signs resembling pernicious anemia, such as glossitis and changes in the structure of the red blood cells.

CASE REPORT

The patient was a fifty year old white Russian female. She entered the clinic of the Cedars of Lebanon Hospital on October 9, 1946. Her chief complaint was pain in the epigastrium for the past two years, loss of weight for six months and loss of appetite for the past three months. She stated that she was perfectly well until two years ago when she developed moderate epigastric pain which was relieved by food. She consulted a local physician who had a gastrointestinal series taken which revealed a gastric ulcer. The patient was placed on an ulcer diet with medical management. About one year ago the epigastric pain became more severe and an additional gastrointestinal series was requested; it showed that the ulcer had become enlarged. The patient was allowed to continue on medical management. About six months before admission the epigastric pain became constant and aggravated by food so that minor relief of pain was experienced only for about thirty minutes between meals. Three months before admission the patient's appetite became poor and she lost about 6 pounds. For the next two months the pain increased in severity; therefore, she entered the clinic.

Past history revealed no serious illnesses. She was operated upon in 1939 for removal of a benign cyst in her left breast, and in 1941 she had a hysterectomy for a uterine myoma. A systemic review other than the gastrointestinal tract revealed no significant symptoms.

Physical examination revealed a slight, well nourished and well developed female. Systemic examination was normal outside of the abdominal findings which was tenderness in the epigastrium and the left upper quadrant. A large, irregular and firm mass filled the entire left mid-epigastrium, the left upper quadrant beyond the costal margin and higher than it was possible to palpate.

X-ray showed a large filling defect of the stomach resembling carcinoma. The other essential laboratory findings showed moderate anemia; blood protein: albumin, 2.7 Gm. and globulin 2.1 Gm.; 2 plus blood in stools.

The patient was prepared for surgery with blood transfusions, amino acids, proteins and vitamins. She was operated upon October 14, 1946, and because the mass extended so far above the left costal margin it was decided that the adequate approach would be through the transthoracic route.

Intratracheal cyclopropane anesthesia was used. An incision was made over the left eighth rib. The incision was developed through the layers and the eighth rib was removed. The seventh and ninth ribs were detached at the posterior attachments and the intercostal nerves ligated. The pleural cavity was entered and the left lung deflated. The pulmonary ligament was isolated and the esophagus was dissected free and followed to the hiatus where the diaphragm was incised and the peritoneal cavity was exposed. The left phrenic nerve was crushed. There was a large ulcerated and fungating lesion of the entire stomach. The stomach was adherent to the pancreas posteriorly. The spleen was removed. The left gastric and epiploic arteries were ligated. The gastrohepatic and gastrocolic omentum were ligated and the stomach freed from the pancreas and separated at the duodenum. The duodenum was closed with three layers of suture, using silk for the outer layer. The jejunum was freed at the ligament of Treitz up to the central mesentery so that the jejunum was brought up antecolic and anastomose to the esophagus without tension. Silk interrupted suture was used in all layers of the anastomosis. The proximal limb of the jejunum was folded over the anastomosis so that this portion was obstructed thus preventing regugitation of

FIG. 1. A barium meal taken five months after total gastrectomy shows an adequate esophagojejunal stoma. There is no dilatation of the esophagus and there is no barium in the proximal loop of the jejunum; there is normal progress of the meal.

alkaline juices postoperatively. An entero-anastomosis between the two limbs of the jejunum was then done. A Levine tube was passed through the anastomosis into the distal limb of the jejunum and that outer portion of the tube which emerged from the nares was sutured to the cheek to prevent possible accidental removal of the tube. The jejunal-esophageal anastomosis was sutured to the diaphragm. The diaphragm was sutured and before the pleural cavity was closed a catheter was inserted through the ninth interspace into the pleural cavity for underwater drainage. The lungs were inflated every twenty to thirty minutes as well as at the conclusion of the operation.

The postoperative course was essentially uneventful. The patient received adequate blood, penicillin, oxygen, intravenous glucose and electrolytes and about 3,000 cc. of amigen by continuous drip through the Levine tube.

The oxygen was discontinued after the third day and the pleural catheter removed after seventy-two hours. She developed a slight cough but no fever; a chest film showed a slight amount of fluid which cleared spon-taneously in a few days. The patient was taking fluids on the fifth postoperative day and she was out of bed on the sixth postoperative day. The skin sutures were removed on the ninth postoperative day and at that time the patient was tolerating a soft diet and the Levine tube was removed.

The patient continued to improve and she was discharged on November 11, 1946. At the time of discharge she was on a large protein and low residue diet. The red blood count was 4,215,000; hemoglobin, 80 per cent; serum albumin, 4.1 Gm.; globulin, 3.9 Gm.; blood chlorides, 495 mg.; a cholesterol 222 mg. She was followed in the out-patient department and she continued to improve and gain weight. She has accommodated to several feedings of a general diet daily without distress.

Comment. This patient was treated medically for two years although her symptoms and x-ray findings suggested ulcer of stomach and early carcinoma. Not until this patient had a large, irregular mass that was palpable was she subjected to surgery. No doubt had earlier surgery been performed more could have been offered this patient. While the condition at the time of surgery appeared hopeless, radical surgery gave this patient comfort during her survival period.

CONCLUSION

Until recently carcinoma of the stomach was generally considered beyond the scope of radical surgery and these patients were placed in a hopeless group. At present we believe that: (1) surgery offers the only hope of cure; (2) palliative resection is worth while; (3) the mortality rate for total resection has progressively diminished due to improvement in technic, improvement in pre- and postoperative management and to improvement and advances in anesthesia and chemotherapy.

The case herein reported is that of a late case of carcinoma of the stomach, with total resection and esophagojejunostomy accomplished through the transthoracic approach. Five months after surgery there

was no evidence of recurrence and the patient was gaining weight and was free from distress.*

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* At this writing, which is twenty-two months since the operation, the patient is alive.

GILBERT and Dunlop of Edinburgh found that postprandial hypoglycemia was a rather common occurrence in patients recently subjected to partial gastrectomy. Clinically, these patients had vertigo, epigastric distress, weakness, sweating, etc., and the authors believe that this syndrome and the so-called "dumping" syndrome are identical. They believe that in each case the basic cause is the rapid absorption of food, especially carbohydrates from the jejunum. This syndrome, therefore, is more apt to occur when the patient's diet is especially rich in carbohydrates. This increased sugar absorption causes an increased insulin secretion and this is eventually followed by a temporary hypoglycemia. The authors therefore suggest that the meals of such patients should contain less carbohydrate and more fat. They also used 1 ounce of olive oil before meals, with resultant success. They also experimented with ephedrine in $\frac{1}{2}$ gr. doses one-half an hour before meals, three times a day, with success. The authors also noticed that these symptoms could often be averted if patients received six smaller meals at more frequent intervals each day instead of three large meals. All these suggestions seem well worth while and this whole study merits further investigation and more consideration. (*Richard A. Leonardo, M.D.*)

CONTROL OF "INTRACTABLE PAIN" BY SPINAL GANGLIA BLOCK

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THE possibility and efficiency of controlling pain originating from the neck down by blocking the spinal ganglia with adequate anestheto-devitalizing solutions are based on definite anatomic and physiologic axioms and clinical results. The reasons why spinal ganglia block will succeed in controlling the modalities of pain, called intractable pain, when blocking or surgical destruction of other nerve structures have failed, will become self evident when the axiomatic data on which it is based are properly analyzed and interpreted.

The anatomo-physiologic data which are accepted as factual knowledge so indisputably that they can be considered as anatomo-histologic and physiologic axioms on the basis of which we can draw exact deductions concerning the effects of blocking of the spinal ganglia are the following:

1. The posterior roots are physically separated in the peridural space from the anterior roots and are composed of and contain all the afferent sensory cerebrospinal and sympathetic nerve fibers which peripherally form a most intricate intimate and complex network specially through the blood vessels.

2. The spinal ganglia are aggregations of nerve cells transforming that portion of the thirty-one pairs of posterior roots located in the peridural space close to the foramina conjugata into comparatively large spindle-shaped swellings.

3. The spinal ganglia are considered as peripheral sensory centers because they contain the cell bodies of all the afferent cerebrospinal and sympathetic neurons.

4. The cell body is the vital trophic center of the whole neuron.

5. In accordance with the Wallerian law, destruction, devitalization or temporary block of the cell body will, of necessity, be followed by simultaneous destruction, devitalization or temporary block of both the central and peripheral processes from the medulla to the tip of fingers and toes and the viscera. This means that all the physiologic and pathologic connections between other nerve structures whose cell bodies have been destroyed, devitalized or temporarily blocked, will per force also be destroyed, devitalized or temporarily blocked. In other words, the whole afferent neuron and its physiologic and pathologic connections will be put out of commission when its cell body is put out of commission.

6. The existence of the peridural space.

7. The physical possibility that anestheto-devitalizing solutions may be introduced in the peridural space with direct effect limited to the spinal ganglia.

8. The comparatively large size of the spinal ganglia practically blocking the posterior aspect of the foramina conjugata.

From the preceding axiomatic data we can logically deduce one of the unique characteristics of spinal ganglia block, i.e., that theoretically it is possible to obtain anesthesia from the neck down without affecting efferent motor structures.

It remains to be proven: (1) Why spinal ganglia block can succeed in controlling the modalities of pain known as intractable pain while blocking of or surgical interventions on other nerve structures fail to control them; and (2) a block limited to the spinal ganglia is clinically obtainable, effective and safe.

In order to understand fully the unique effectiveness and safety of spinal ganglia block one should consider the complexities of nerve structures and specifically the fact that these normal complexities become

perversely more complex when nerve structures are deeply affected directly and indirectly by complex pathologic conditions, such as malignancies. The evident intricacies and complexities of the peripheral processes of the sensory neurons, especially in relation to blood vessels, are generally well known while those of the central processes are less known. Therefore it might be useful to review briefly the most striking.

"Afferent Paths in the Spinal Cord. We have been at some pains to make clear the course and distribution of the dorsal root fibers within the spinal cord because all afferent impulses which reach the cord are carried by them. Interoceptive fibers from the viscera, proprioceptive fibers from the muscles, tendons and joints, as well as exteroceptive fibers from the skin are included in these roots; and among the latter group are several subvarieties, mediating the afferent impulses out of which the sensations of touch, heat, cold, and pain are elaborated."[1]

"The extreme length which the process of one of these neurons may attain will be appreciated if one considers that a single nerve cell located in a lumbosacral ganglion may not only send a peripheral process to one of the toes but its central branch, after entering the spinal cord, may bifurcate into two branches, one of which ascends the whole length of the spinal cord. In this case, the total length of the neuron would equal approximately the distance from toe to nape of neck."[2]

"The descending branches pass through many segments of the spinal cord, so that the branches from the sensory nerves of the cervical plexus can be found in the sacral segments."[3]

Because of these and other still unknown complexities, smooth, normal function of nerve structures is possible only when their normal anatomohistologic integrity allows each nerve structure to perform the special duty assigned to it by evolution, thus assuring a definite physiologic pattern of coordinated, cooperative, interdependent functional activities. How is this pattern distorted in cases suffering from intractable pain? In peripheral sensory neurons, beside the cell bodies, three definite portions can be distinguished each with a specific limited function: (1) the receptors for the perception of stimuli; (2) the fibers for the transmission of nerve impulses; (3) the means of synaptic connection with other neurons. In the central sensory neurons there are no receptors; their nerve fibers end on both sides with structures for interneuronic connections through synapses. It is essential to understand and consider the capital importance of the following physiologic axioms which establish clearly the essential difference between the functional behavior of normal neurons and those pathologically altered in order to appreciate the unique effectiveness of spinal ganglia block in controlling modalities of pain considered up to now intractable:

(1) The only portions of the nerve structures intended to be stimulated are the receptors. In order to attain this aim evolution has devised well known efficient means which simultaneously facilitate stimulation of the receptors and prevent stimulation of any other portion of the nerve structures. It is imperative that it be so, because the function of the sensorium is informative and the receptors are only and very complex organs of different histologic structure developed by evolution for the sole purpose of furnishing specific information. Consequently stimulation of any other portion of the nerve structures would cause confusion, to say the least, and the normal pattern of nerve function can be maintained only if the normal cycle of impulses starts exclusively from the informative organs, namely, the receptors, runs to the centers and from the centers to the effectors. It is axiomatic knowledge that exclusive one way direction, centripetal for afferent impulses and centrifugal for motor impulses, is essential to the normal function of nerve structures. (2) Direct stimulation of all varieties of nerve fibers starts impulses which run in both

directions along the fibers, i.e., centripetally and centrifugally. (3) Evolution has assured the one direction of impulses by placing both the receptors and the effectors at the extreme periphery, by adequate insulation of nerve fibers singly and in group and by the polarity of the synapses, thus forcing the spreading of the nerve impulses in certain predetermined directions and to predetermined structures. (4) Nerve current, analogously to electric current, escapes along the lines of minor resistance when the insulation of its conductors, i.e., nerve fibers, becomes inadequate. (5) The factors which assure adequate essential insulation of nerve structures are: (1) proper media; (2) normal intercellular tension; (3) biophysical means, such as neurilemma and myelin sheaths.

Although only the modalities of intractable pain which are caused by malignancies are hereby discussed, evidently, except for secondary peculiarities, the same considerations apply to all modalities of chronic pain. In malignancies, especially after ineffectual deep therapy, the intercellular tension becomes abnormal, often being substituted by true compression, the media are always profoundly altered and the biophysical means of insulation are either totally destroyed or seriously damaged. Cross currents resulting in abnormal cross stimulation of neighboring nerve fibers follow inadequacies of insulation. Nerve short circuits physically and dysfunctionally analogous to electric short circuits result between neighboring fibers when their insulation becomes inadequate causing disconcerting complex abnormal interactions between the various afferent and efferent neurons. Moreover, stimulation and the generation of impulses does not remain limited to the receptors; damaged afferent and efferent fibers turn into linear receptors which are easily stimulated directly and through abnormal cross currents from neighboring fibers. Stimulation of the highly irritable nerve fibers perverts, distorts and completely disrupts their

normal function, which is limited to one way specifically predetermined conductivity. Volleys of abnormal impulses chaotically jump to and from afferent and efferent, fast and slow cerebrospinal and autonomic fibers and, running antidromically, disrupt synapses by butting against them and in inextricable turmoil riotously bombard centers, effectors and receptors to which they were not destined.

Proper consideration of the Wallerian law explains clearly why the volleys of these abnormal impulses, which cause the well known simultaneous sensory, motor, circulatory and secretory dysfunctions observed in cases of malignancies with unbearable and intractable pain, can evidently be stopped only by blocking the spinal ganglia with appropriate anesthetodevitalizing solutions. All the pathologic connections created by the malignancy between any and all portions of the peripheral afferent sensory neurons of the focus doloris and any and all other nerve structures must be absolutely thoroughly destroyed in order to prevent any painful impulse generated therefrom being somehow shortcircuited to the centers. The importance of doing so becomes self-evident if we consider the well known fact that thorough and completely done destructions of nerve structures either by alcohol or surgery have often failed not only to control the pain permanently but, beside unbearable functional disturbances, have also been the direct cause of most distressing additional new modalities of pain, as exemplified by the unbearable girdle pain which appears after chordotomy. It is self-evident that these cases prove that all the pathologic connections caused by pathologically shortcircuited nerve structures could not be destroyed by the procedures adopted. Obviously devitalization of the vital trophic center of the whole neuron, i.e., the cell body located in the spinal ganglia will automatically, according to the Wallerian law, devitalize the whole neuron in its entirety together with all its normal and pathologic con-

nections, whether the neuron is a short one or its processes extend from the medulla to the tip of the toes. Monsieur de La Palice would say that devitalized receptors cannot be stimulated and generate impulses; devitalized fibers cannot transmit impulses nor be directly stimulated; devitalized interneuronic connecting organs cannot make synaptic connections. Stated in different words, the fact remains that devitalized neurons cannot under any circumstances generate nor transmit impulses painful or otherwise. Consequently, if our fundamental axiomatic anatomo-histologic and physiologic knowledge of nerve structures is correct, it can be logically asserted that blocking of the spinal ganglia containing the cell bodies of the neurons innervating the focus doloris with appropriate devitalizing solutions will positively control the modalities of pain, up to now called intractable, because no impulse can either originate or be transmitted from the loci, the neurons of which have been devitalized in their entirety.

CLINICAL ASPECTS
OF SPINAL GANGLIA BLOCK

The spinal ganglia can be easily and effectively blocked through the peridural route. It is fundamentally important to establish immediately that the type of block variously designated as peridural or epidural, caudal anesthesia or block and spinal ganglia block have in common only the route chosen to effect them, *nothing else*. Their aims and the mechanism of their effects and technic are radically different. It suffices to state that with peridural anesthesia, efferent and afferent structures are simultaneously and equally blocked efficiently because the structures actually blocked are the first portions of the mixed spinal nerve which lie outside of the peridural space. As a matter of fact, peridural anesthesia or block is a misnomer because the blocking effects take place within and beyond the foramina conjugata through which most of the anesthetic solution is

compelled to ooze out of the peridural space. This statement is not meant as a disparagement; it is made solely in order to clear the fundamental differences between spinal ganglia block and the misnamed peridural block, which is actually the ideal method of obtaining the absolutely perfect and most effective paravertebral block. As a matter of fact, no other artifice but the technic of peridural anesthesia by which the anesthetic oozes out of the foramina conjugata could possibly so thoroughly surround and bathe without waste and, consequently, so ideally block the mixed spinal nerves at their origin.

Spinal ganglia block means exactly a block limited to the spinal ganglia which is proven by the fact that patients anesthetized, for instance from the waist down, can freely walk, their walk resembling the walk of tabetics. The solution injected in the peridural space with the aim of blocking solely the spinal ganglia must remain wholly and exclusively in the posterior aspect of the peridural space and constitute a reservoir of devitalizing material, the action of which is slow but lasts a considerably long time. The solution must be concentrated and its amount must be absolutely limited to that which will saturate only the posterior aspect of the peridural space. Weak, abundant solutions cannot produce spinal ganglia block.

Clinical considerations on spinal ganglia block used in over 2,000 surgical cases in the last ten years are completely bypassed, except to mention that the addition of alcohol to the anesthetic solution, which turns it into an anestheto-devitalizing solution, is the only variance when spinal block is used for the control of chronic pain. The addition of the alcohol to the basic surgical 10 per cent solution of novocaine gives it devitalizing characteristics absent in the plain novocaine solution. The amount of alcohol added varies from 5 to 25 per cent, according to the degree of devitalization desired. The following considerations have guided the

determination of the amount of alcohol to be added to the basic 10 per cent novocaine solution. It is essential to avoid the caustic action of pure and high dilutions of alcohol in the peridural space. It is not necessary to destroy the spinal ganglia in order to obtain pain control. It is practically always possible to control even the most severe pain without penalizing the patient with total loss of sensation. This statement requires some explanation. It is generally admitted that the smaller naked fibers are responsible for pain. The cell bodies of the smaller naked fibers are proportionally also smaller and more easily affected by the anestheto-devitalizing solution than the cell bodies of the myelinated fibers which mediate fundamental sensations most worthy of preservation. The greater the amount of alcohol added to the basic 10 per cent novocaine solution the more extensive is the devitalization of the cell bodies. In other words, the larger cell bodies require a larger amount of alcohol than the smaller to be devitalized. Consequently, it is scientifically logical and clinically most advantageous to limit the devitalization to the smaller cell bodies and preserve the larger ones when possible by limiting the amount of alcohol to the minimum required for the control of pain.

Evidently the anatomo-histologic and clinical factors concerned with the effective control of intractable pain are too many and too complex to be fully discussed in a short paper, but the following basic outline of conduct will aid the physician to deal with his patients in the most humane, scientific and effective manner. The basic principle is that preservation of as much normal sensation as possible is of the utmost importance. Consequently, because of the impossibility of determining a priori how the spinal ganglia of each patient will respond to the devitalizing process and of the fact that spinal ganglia block is neither a difficult nor an expensive procedure, it is preferable to repeat the block than to use

the larger proportions of alcohol. The average effective amount of alcohol has been found to be from 5 to 15 per cent. Permanent control of pain, with preservation of normal sensations, has been obtained in some cases either with a single block or with blocks repeated at various intervals and the addition of only 5 per cent alcohol to the basic 10 per cent novocaine solution. These represent the absolutely ideal results which, however, unfortunately cannot be expected in all patients and which are not obtainable in those whose psyche has been deranged to the point that even the slightest ordinary pain and simply the fear of pain has become intolerable and who confuse pain with other miseries inherent in malignancies. In these cases it is advisable to use immediately the higher proportions of alcohol, namely, 15 per cent and repeat the block with higher percentages, if necessary; or when conditions are desperate and there is nothing to preserve, to use the highest percentages directly, namely, 20 or 25 per cent. The best guide on the optimum percentage of alcohol for each patient is the amount of cooperation that he or she offers. With the most cooperative patients the treatment should be started with the basic 10 per cent novocaine solution containing 5 per cent alcohol, and the block repeated either with the same percentage of alcohol or an increased percentage according to the devitalizing effects produced by the previous percentage, taking notice of the fact that the devitalizing effects and consequent period of pain relief of each successive block lasts much longer than those of the preceding blocks. Thus, while an intelligent, cooperative patient may be ideally treated with a series of blocks done with the 5 per cent alcohol percentage with consequent preservation of normal or quasi normal sensation, the very uncooperative, psychically upset patient must be treated progressively less ideally with a single or a couple of blocks and consequent more or less marked loss of sensation.

TECHNIC

The technic of spinal ganglia block is *per se* not more difficult than an ordinary spinal tap. However, its efficiency and absolute safety depend solely on whether or not all the safety measures are observed which have proven 100 per cent reliable in over 2,000 cases, some of whom presented very serious technical and clinical difficulties.

The anestheto-devitalizing solution must diffuse along the posterior aspect of the peridural space by saturation of the loose connective tissue located therein. In order to prevent its spreading to the anterior aspect and oozing out of the peridural space through the foramina conjugata, the injection must be done with just enough pressure on the plunger to have the fluid drop out of the needle. A practical way to learn to inject the solution at the proper *slowness* is to separate the syringe from the needle left *in situ* after each cc. injected. Not a drop of solution will drop from the needle if the injection has been done with the proper slowness, which is facilitated by the use of the finest spinal needles. The disappearing drop phenomenon will give absolute certainty that the point of the needle is in the peridural space and can be produced thus: The spinal needle is introduced into the tissues while 1 per cent solution of novocaine is gently injected into them. When according to the thickness of the area the needle has been advanced toward the spine 3 to 5 cm. the syringe is detached and the needle is left *in situ*. The physician verifies if a drop of solution is hanging on the shank of the needle; if not, he just puts a drop there. He then very slowly advances the needle toward the spine. If he proceeds slowly, he will see that the drop hanging from the shank of the needle is all of a sudden sucked in. This means that the point of the needle is within the peridural space, and thus by maintaining the needle *in situ* there cannot be any danger of introducing the solution into the subdural space.

The sitting position is the one to be preferred during the injection, after which the patient is immediately placed comfortably on his back for several hours. Anesthesia appears after ten to twenty minutes. Each cc. of solution blocks about two metameres.

Because of the overlapping of peripheral nerve fibers originating from adjacent roots, it is advisable always to block a couple of pairs of ganglia above and below the fibers which innervate the focus doloris.

It is understandable that in a class of patients such as those who suffer from various modalities of intractable pain, technical and clinical difficulties will be met. Obviously the most serious is the failure to detect the peridural space and this unfortunately often occurs in patients who need the relief most, namely, those who suffer from inoperable malignancies of pelvic organs. In these cases age and deep therapy have caused deteriorations of the peridural space which prevent the production of the disappearing drop phenomenon and render any other means of ascertaining whether the point of the needle is or is not in the peridural space very aleatory. I have been forced to adopt procedures which made spinal ganglia block very difficult and not always ideal, until recently I discovered that even in the most desperate cases the spinal ganglia up to the fourth and fifth dorsal pairs could be ideally and without difficulty blocked through the sacral route. To do so, after the needle is introduced through the sacral hiatus to the height of the second sacral vertebra, the patient is turned on the back, placed in the Trendelenburg position and the injection done with the same precautions required for block done with the patient in the sitting position. In fact the results have been so satisfactory that I consider the sacral route preferable in the aged and in those who for any reason cannot be placed comfortably in the sitting position. When the sacral route is chosen, the small detail which I use routinely in all spinals of

nicking the skin with a carbolized scalpel[4] at the point where the needle is inserted should be adopted in order to prevent any possibility of infection of the peridural space. When the peridural space cannot be detected in the upper spine, the block may be attempted safely if the following precautions are faithfully observed: In these cases after the spinal needle has reached the subdural space, as evidenced by the appearance of the spinal fluid, it is withdrawn slowly until the spinal fluid ceases to drop out, which indicates that the needle is in the peridural space. An empty syringe is connected with the needle left *in situ* and the plunger is retracted; failure to aspirate spinal fluid is an indication that the point of the needle is not within the dura. The syringe containing the anesthetodevitalizing solution is then substituted for the empty syringe and not more than 2 cc. are injected. If no anesthesia appears within five minutes, it means that the solution has not been injected within the dura and it is safe to proceed and inject the rest. When unilateral block is desired, the patient is placed during the injection and is kept for at least a couple of hours on the flank, with the body slightly leaning toward the back, so that by gravitation the solution is injected and remains on the side of the posterior peridural space where the ganglia to be blocked are located.

CONCLUSIONS

In the cases of so-called intractable pain when pain has often ceased to be a symptom and has become a true most serious disease, neither the individual nor his nervous system are normal. The pathologic conditions which are the direct cause of the severe chronic pain have disrupted and continue to disrupt not only the psyche but also the normal pattern of sensations physically, because they have disrupted the normal anatomo-histologic pattern of nervous structures and of their media. Nerve structures of the focus doloris have become shortcircuited to distant nerve structures especially through the nerva vasorum and the sympathetic fibers scattered in the tissues which continue to send algogenic impulses to the centers, unless and until all the peripheral afferent neurons are completely devitalized in their entirety and thus cease to have any pathologic connections with other near and distant nerve structures. Consequently we can logically conclude that a combination of anatomo-histologic, physiologic, pharmaceutical and clinical factors make the spinal ganglia a unique locus ideally suited for a uniquely effective safe control of all modalities of pain, including those up to now considered intractable and originating in organs the nerve fibers of which have their cell bodies in the spinal ganglia. This means that spinal ganglia block will effectively and safely control pain originating in all the organs from the neck to the toes. In justice to patients it would seem reasonable to suggest that before surgery is resorted to spinal ganglia block should be given a thorough trial.

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COMPLETE LIGATION OF THE ABDOMINAL AORTA FOR ANEURYSM BY THE SPIRAL METHOD*

A CASE CONTROLLED BY AORTOGRAPHY

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ONE hundred thirty-one years have passed since Sir Astley Cooper[1] performed the first ligation of the abdominal aorta for aneurysm and the problem continues to fascinate surgeons. His patient, a thirty-eight year old porter, was operated upon April 9, 1817, and survived for three days. The report of the autopsy does not give the cause of death. In 1829 James[2] performed the second reported ligation on the aorta of a man forty-four years of age. His patient lived for only four hours. In 1834 the third ligation, by Murray[3] was done on a man thirty-three years old who lived only twenty-three hours. The autopsy proved that the aneurysmatic sac was gangrenous. The fourth ligation of the abdominal aorta was performed by Borges Monteiro[4,5] in Brazil in 1842. He was the first to establish the possibility of completing this operation without causing gangrene of the inferior limbs since his patient lived eleven days. Following these four cases which belong to the pre-anesthetic days of surgery, ten more ligations were done during the nineteenth century by South,[6] MacGuire,[7] Stokes,[8] Watson,[9] Czerny,[10,11] Milton,[12] Keen,[13] Körte,[14] and Tillaux.[15]

In 1856 South performed the first ligation of the aorta under anesthesia. In 1868 MacGuire also attempted the operation, but it resulted in complete failure because the patient showed paralysis of the inferior limbs and incontinence of urine after the operation, surviving eleven and one-half hours. Autopsy showed that the left ureter also had been included in the ligature. In 1869 Stokes used a special technic to obtain a temporary ligation. His report reads as follows: "A silk ligature was applied, the ends of which were attached to a Porter artery-compressor, the object being to apply a temporary ligature." After the operation the patient showed paralysis of the inferior limbs and died of shock thirteen hours later. In 1869 Watson published a report of his own operation. He gave reference neither to the date of the operation nor to the personal data of the patient, but he said that nine weeks before the aortic ligation the external iliac artery had been ligated. This patient lived sixty-five hours, developing gangrene of both legs forty-eight hours after the operation.

The two cases of Czerny were the first in which ligations of the abdominal aortas were made in patients without aneurysms. The first patient operated upon in 1870 was a twenty-seven year old soldier who had received a bullet wound in the iliac artery. He died twenty-seven hours after ligation of the aorta which was mistaken for the common iliac; death was caused by sepsis and hemorrhage. In 1879 Czerny was obliged after nephrectomy to perform a ligation between the two renal arteries because of uncontrollable hemorrhage. The patient lived only ten hours after the operation. In 1890, Milton performed a ligation with silk in a patient with a ruptured aneurysm. The patient, a man forty-five years old, died of anemia and shock after twenty-four hours. In 1899 Körte ligated the abdominal aorta of a man twenty-eight years old who suffered a rupture of the sac after ligation of

the common iliac which had been done thirty-six days before. His patient died of hemorrhage and shock one hour after the operation.

During the nineteenth century the patient who lived the longest (forty-eight days) was operated upon by Keen in 1899. He was a fifty-two year old man. The ligation was made with silk below the diaphragm but eight days later the ligature gave way which improved the blood supply of the limbs. The aneurysmal bruit reappeared, and the abdominal distention was evident again. The patient died of hemorrhage of the aorta at the level of the ligature. In 1900 Tillaux operated upon a fifty-six year old man with a ruptured iliac aneurysm. He, like Czerny, performed an aortic ligation by mistake thinking he had the common iliac; the patient survived thirty-nine days. Although Tillaux gave no details concerning the death, it would seem that the cause was hemorrhage due to failure of the ligature.

As a valuable contribution to the problem of ligation of the abdominal aorta during the last century one must consider the experimental work of Kast[16] which was published in 1880. He presented interesting diagrams showing the collateral blood supply obtained after ligation of the aorta in animals. He arrived at the conclusion that animals like guinea pigs, which have a weak abdominal wall, are subject to paralysis of the posterior limbs and of the sphincters because the possibilities of collateral circulation are very limited. In animals with a thick abdominal wall, e.g., dogs and cats the results are good. He concluded also that the heart does not suffer from a ligation of the aorta. Of the fourteen ligations performed upon human beings during the last century the only favorable knowledge which we have gained is that ligation is possible in a great many cases from the point of view of blood supply.

At the beginning of the twentieth century, in spite of the progress made in the art of surgery, few surgeons cared to attempt ligation of the aorta due to the disastrous results previously described. Therefore, until 1920 only seven ligations were performed, four of them by the same surgeon. In that period the greatest preoccupation was with trying new types of ligatures because of the complete failure of the use of thread during the previous period. In 1901 Morris[17] operated upon a colored woman twenty-four years old. The aneurysm extended from the coeliac trunk to the mesenteric vessels. He performed a temporary ligation distal to the aneurysm using a rubber tube held with a clamp. He observed sphincter incontinence during the first hours and the ligature was taken out twenty-seven hours after the operation. The patient died three days after the operation from intestinal gangrene caused by the presence of the clamp. Use of the rubber tube was again tried by Scott[18] in 1905 in a patient with a bullet wound. The patient died one hour after the operation. Halsted,[19] in an attempt to avoid infection and at the same time to effect a gradual occlusion of the aorta, inaugurated the use of an aluminum band. However, he was not successful in the operations which he performed in 1906, 1908, 1909 and 1911. Three of his patients on whom he used this band died from hemorrhage twelve hours, eighteen days and six weeks, respectively, after the operation. The fourth patient, on whom he used cotton tape hoping to use the aluminum band later, died of infection twelve hours after the operation. In 1917 Heuer[20] had the same unfortunate result from use of the aluminum band because the aorta ruptured at the level of ligation. His patient survived thirty-nine days. This first period of the twentieth century shows us that the rubber tubes and metallic bands are inadequate for ligation of the aorta.

In 1920 Vaughan[21,22] inaugurated a new period in the history of abdominal aorta ligation, his patient surviving for a period of two years and one month which was a

compensatory result. Unfortunately, however, the patient was not cured of the aneurysm. The patient was a thirty-nine year old man who was suffering from an aneurysm of the abdominal aorta which reached the level of the superior mesenteric artery. Vaughan used cotton tape and performed a distal ligation, but he obtained only partial occlusion of the vessel as verified by the autopsy findings. The aneurysm had increased in size without breaking.

Reid[23,24] had a chance to perform two ligations of the aorta. The first in 1921 was unfavorable because the aneurysm was located at the height of the inferior mesenteric artery. He performed first a partial ligation of the aorta between the inferior mesenteric artery and the renal arteries using cotton tape. Four and one-half months later, in a second operation in which he performed a new ligation upon the coeliac trunk, the patient died of a rupture of the aneurysm. In 1928, Reid performed a ligation of the thoracic aorta in a patient with an aortic aneurysm at the level of the coeliac trunk. He inserted a fascial plug with fixation by silk sutures. This patient, a thirty-five year old woman, died twelve hours after the operation from a secondary hemorrhage of an intercostal vessel.

Watts[25] also performed the operation twice within six months. In February, 1923 using cotton tape he performed a ligation above the renal arteries in a patient in whom the aneurysm extended from the bifurcation to the level of the superior mesenteric artery. However, this patient developed postoperative anuria and died twenty-two hours after the operation. Three hours before his death he was operated upon again to ease the ligature. In September, 1923 Watts attempted the operation again with the use of cotton tape. The patient was a sixty year old woman. The aorta was partially ligated with cotton tape immediately below the superior mesenteric artery. The patient survived three and one-half years, dying

of a rupture of the aneurysm. In spite of this eventual outcome the result obtained by Watts represents a great improvement.

In April, 1923 Matas[26,27] operated upon a colored woman twenty-eight years old. He performed a ligation of the abdominal aorta with two cotton tape ligatures. The tapes were placed in juxtaposition, one above the other. This patient lived for one year and five months and was the first patient who died of a cause not related either to the aneurysm or to the ligature. The report of Matas was first given in 1925 and later in 1940. The autopsy proved that the cause of death was a tuberculous pulmonary hemorrhage. The aneurysmal sac was almost obliterated, but the occlusion of the aorta was not complete due to the yielding of the ligatures which were well tolerated by the tissues and caused no damage to the artery. This case of Matas showed the first real success obtained from ligation of the abdominal aorta.

In 1926 Brooks[28] reported one of the more instructive cases of ligation of the abdominal aorta which was performed in 1925. The patient was a fifty-nine year old colored man, who showed a large aneurysm of the terminal aorta below the inferior mesenteric artery. Brooks attempted an aneurysmectomy but this had to be abandoned because of a rupture of the sac followed by intensive hemorrhage. He was obliged to limit his operation, performing the ligation of the aorta below the inferior mesenteric artery. He used fascia lata above and silk thread below. The patient died three months later from intestinal occlusion. Autopsy proved that the silk thread had partially cut the wall of the vessel and that the strip of fascia lata had yielded. The aneurysm had been very large and had caused erosion of the inferior lumbar and the superior sacral vertebrae. According to Brooks, use of the fascia lata above and the silk below was based on the idea of reducing the blood pressure on the silk. Complete occlusion of the aorta and obliteration of

the sac must be attributed to this special technic.

In 1929 Andrus[29] was the first to divide the aorta between two ligatures made with cotton tape. The aneurysm was situated immediately below the diaphragm, the vessel being cut in the thorax. His patient lived only one and one-half hours, dying from shock. Also in 1929 La Roque[30] performed partial ligation of the aorta with umbilical tape and heavy silk upon a woman thirty years old. In his paper he reported that the patient was in good condition after fourteen months, showing reduction of the aneurysm which was localized in the right common iliac artery.

The contribution of Bigger[31] to surgical treatment of the aortic aneurysm is of exceptional value. He operated upon two patients. In 1938 he performed a ligation with fascia lata above the inferior mesenteric artery in a man fifty-four years old. After twelve hours "the right leg was becoming shrivelled in appearance and showed areas of discoloration over the dependent portions; the right femoral vein was ligated with the hope that this might improve the circulatory balance in that leg." The patient developed left-sided heart failure with pulmonary edema and died eighteen hours after ligation of the aorta. Autopsy showed that the aneurysmal sac was filled by fresh clot, the lumen of the external iliac artery was occluded by arteriosclerotic changes and a fresh thrombus filled the hypogastric artery. Bigger explained the acute circulatory deficiency as follows: "Since the autopsy showed long-standing occlusion of the external iliac artery, the acute circulatory deficiency following aortic occlusion is adequately explained by the formation of a clot in the hypogastric artery and its major branches, because, under the circumstances, this vessel was an essential collateral channel." In relation to the failure of the left side of the heart he stated that, "the occlusion of the aorta per se probably played an unimportant part in the outcome, and abdominal exploration

without aortic occlusion might well have led to the same result." The author partially agrees with him and calls attention to the difficulty in establishing a prognosis in patients with ligation of the abdominal aorta. The second patient operated upon by Bigger was the first success of the aortic aneurysmorrhaphy according to the technic of Matas. The latter had been attempted four times before Bigger by Lozano,[32] Munro,[33] Crile[34] and Kümmel,[35] respectively, but had always resulted in failure. Bigger operated upon his patient, a twenty-five year old man who had a traumatic aneurysm of the terminal aorta, on September 14, 1938, performing a ligation with fascia lata. He observed neurologic changes as a result of temporary anemia of the peripheral nerves of the lower extremities but the patient reacted quite well. On January 10th he performed an aneurysmorrhaphy but the aneurysmal sac was reduced to about one-half its previous size and was not pulsating. This patient was alive and apparently well after sixteen months.

Another good result in a sixty-one year old man was obtained in 1939 by Elkin[36] in a ligation partially occluding the aorta with two cotton tapes. Following operation, the patient complained only of some coldness of the legs but this disappeared in two days. Eleven months after operation the mass was considerably smaller but it showed slight pulsation and a definite systolic bruit could be heard over it. Complete occlusion had not been accomplished.

Morton and Scott[37] in 1942 performed a ligation upon a man who already had undergone a previous abdominal exploration. The operation was done after rupture of the sac which had been followed by hematomas collected in the retroperitoneal space. Two cotton tapes were used for the ligation. The patient, a fifty-two year old man, developed gangrene of the left leg which necessitated amputation ten days after ligation of the aorta. After seven

months this patient died of an acute abdominal condition. Autopsy showed a sacular secondary aneurysm immediately above the ligature and a fistula connecting the aorta with the jejunum. In the same

layers of ribbon gut. The patient developed Cheyne-Stokes respiration and died twenty-four hours later. Finally in August, 1943 the author performed the thirty-sixth ligation of the abdominal aorta upon

TABLE I

CASES IN WHICH IMPROVEMENT WAS OBTAINED

Type of Ligation	Surgeon	Year	Material Used	End Results
Distal ligation.............	Watts	1923	cotton tape	Survival 3½ years; death due to ruptured aneurysm
Proximal partial ligation......	Vaughan	1920	cotton tape	Survival 2 years and one month; aneurysm not cured
	Matas	1923	cotton tape	Survival 1 year and 5 months; death due to another cause; aneurysmae sac practically closed
	Elkin	1939	cotton tape	Survival up to publication (11 months); reduction in size of the aneurysm which continues pulsating
	La Roque	1929	umbilical tape and heavy silk	Survival up to publication (14 months); marked improvement
Proximal total ligation.......	Brooks	1925	fascia lata and silk	Survival 3 months; death due to intestinal occlusion; aneurysm cured; aorta occluded
	Prudente	1943	spiral of fascia lata	Survival 3½ years to date of this writing; aneurysm clinically cured; aorta occluded
Proximal total ligation and aneurysmorraphy.	Bigger	1938	fascia lata	Survival 16 months up to publication; aneurysm clinically cured; aorta occluded

year Monahan[38] used the method advised by Owings[39] who, with the use of rubber bandage, made an experimental occlusion of the thoracic aorta in dogs. Monahan performed the operation in three stages. On March 20, 1942, he made a three-fourths partial occlusion with rubber bandage. In a second stage on April 11, 1942, he totally occluded the aorta again using rubber bandage. Finally on May 15, 1942, he completed the ligation and section of both common iliac arteries with silk. This patient was discharged on June 2, 1942, but died from hematemesis. Autopsy showed a perforation of the aorta next to the superior rubber ligature, a sacular aneurysm and an aorticoduodenal fistula. The edge of the rubber ring probably destroyed the arterial wall.

In March, 1943 Ormond, Harkins and Smith[40] operated upon a patient with a ruptured aneurysm of the abdominal aorta, performing the ligation with two

the patient whose case is reported in this paper.

Until today improvements were obtained in only eight patients of the fifteen operated upon after 1920. (Table I.) Among this group in only three (Brooks, Bigger and Prudente) was total occlusion of the aorta obtained. Fascia lata was used in these three patients with the addition of silk in the first, aneurysmorrhaphy in the second and only fascia lata by the spiral method in the third. Cotton tape was most useful but until now it does not effect total ligation in a human being.

CASE REPORT

The patient, A. M. N., a white man forty-four years old, was admitted to the Santa Cruz Hospital, São Paulo, Brazil on August 29, 1943. He complained of a tumor in the abdomen and extreme pain in the right inferior limb.

Past history revealed that he had acquired a syphilitic ulcer twenty-two years before and had undergone treatment for the ulcer until it

FIG. 1. Radiograph showing deviation of the right colon and cecum before operation.

FIG. 2. Photograph of the scar showing the incision line.

was healed. However, he received no treatment for his basic condition.

The present history disclosed that on April 18, 1943, while resting, he felt an acute pain in the posterior side of the right leg. Some relief was obtained from a hot bath. The next day the pain reappeared and continued intermittently. On May 15 the pain started in the abdomen as well and he observed a soft excrescence in the lower abdomen. On May 20th the pain extended to the right gluteal region and from this day on it was impossible for him to walk; he was obliged to lie down with his thighs flexed on his abdomen. From the time that the disease started he reported complete "impotentia coeundi." On August 8th the pain became so intense that morphine was employed; this condition persisted until August 26th when morphine was inefficient and he agreed to enter the hospital. On August 27th he was sent to the Hospital do Braz where an x-ray with barium was made. During the period of his illness he lost about 28 pounds, his actual weight being 108 pounds at this time. On August 29th he was put under the author's care at the Hospital Santa Cruz.

Physical examination revealed that the patient was a white male, very weak and emaciated with his facies contracted with pain. He was obliged to remain in the dorsal recumbent position with his thighs flexed on his abdomen due to the spasm of the iliopsoas muscles. His temperature was 36.6°C., pulse, 72; respiration, 26 and blood pressure 120/70. The only important findings were those presented by the abdomen and lower extremities. Upon inspection one could see a pulsating mass in the lower abdomen. The mass measured about 5 inches from right to left. Its upper margin was at the level of the umbilicus and the inferior limit could not be found because the pulsating mass was hidden by the inguinal rigid elements. Thrill was audible along the whole extension of the tumor, its pulsation synchronizing with the heart beat. All arteries of the lower extremities were pulsating well. The previous barium enema showed a deviation of the right colon and cecum to the medial part. (Fig. 1.) Blood examinations were as follows: coagulation time, 10 minutes; bleeding time, 2 minutes; red blood count, 3,800,000; hemoglobin, 70 per cent; white blood count, 7,000; Wassermann and Kahn reactions, negative. Urine analysis was negative.

Diagnosis: Aneurysm of the abdominal aorta and the right common iliac artery.

Operation was performed on August 30, 1943. Spinal anesthesia with 150 mg. of scurocain followed by a veritol injection was administered. The thighs could be extended; the spasm of the iliopsoas muscles disappeared. The abdominal wall was incised at the medial line 2 inches above and 3 inches below the
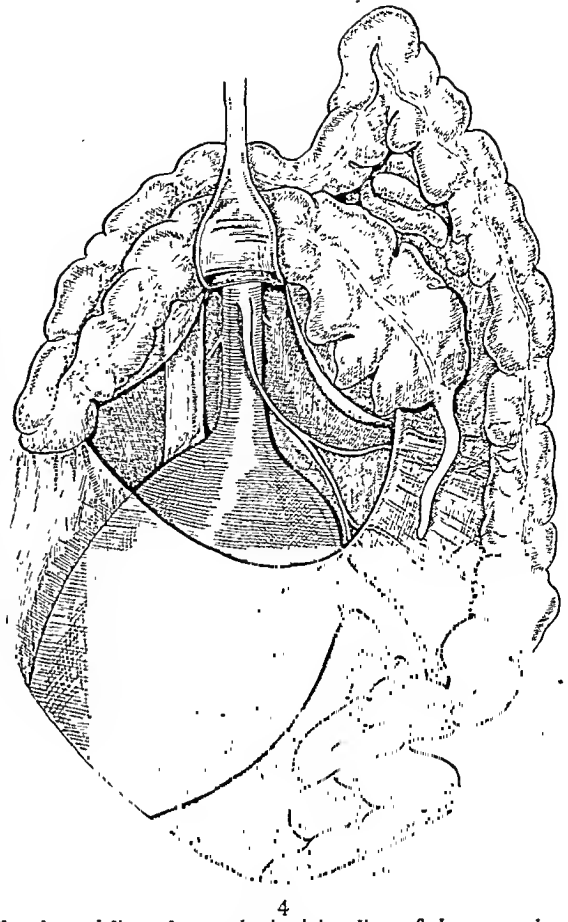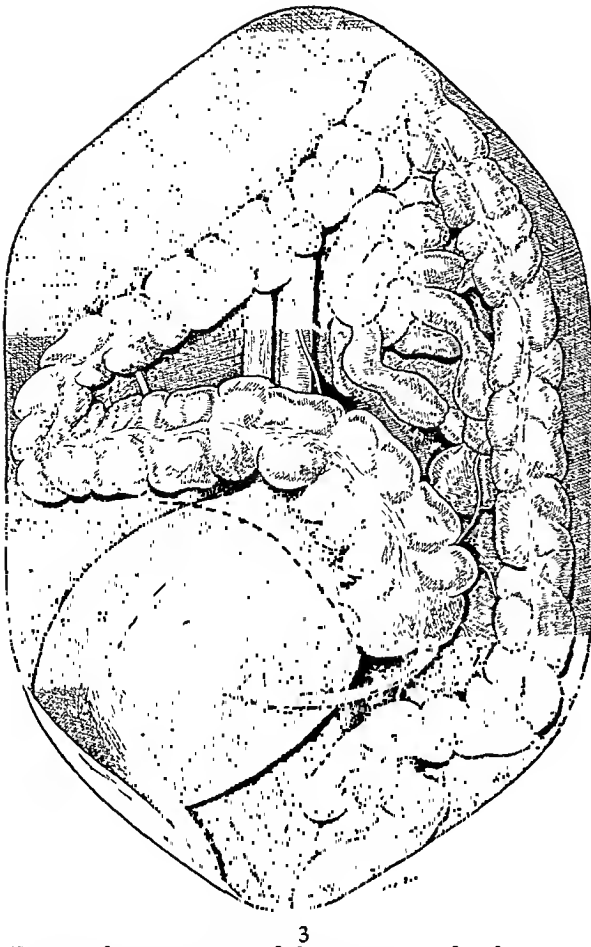
FIG. 3. The appearance of the aneurysm after laparotomy. The dotted line shows the incision line of the posterior peritoneum.

FIG. 4. The appearance of the vessels after dissection of the posterior peritoneum.
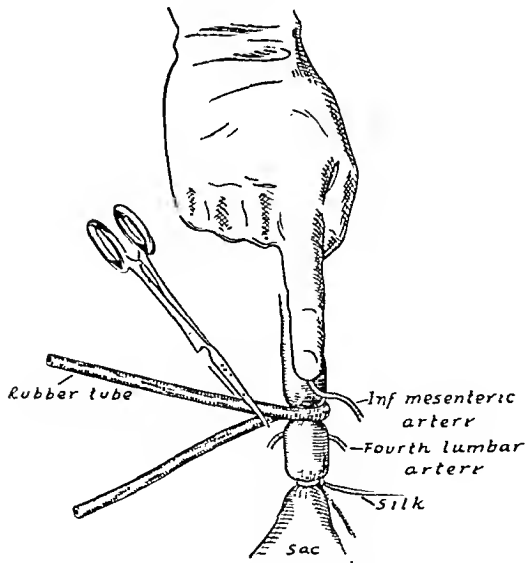
FIG. 5. First stage of spiral ligation, temporary occlusion of the aorta with a rubber tube; temporary smashing with silk.
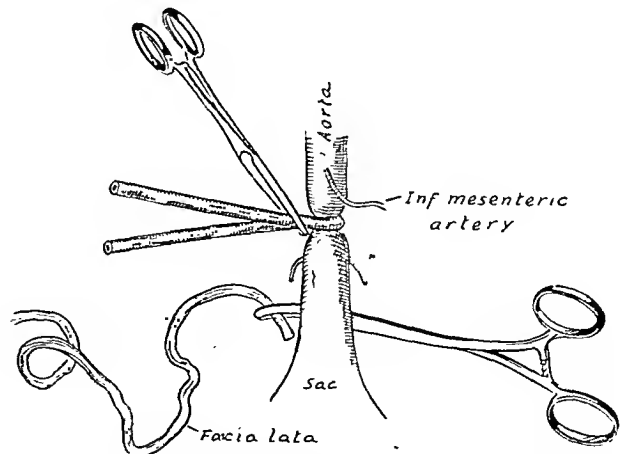
FIG. 6. Second stage of spiral ligation; the silk thread was removed. The fascia lata is passed behind the aorta.

umbilicus. (Fig. 2.) The aneurysm was seen immediately; it was covered by the posterior peritoneum. The lower part of the ascending colon and the cecum were displaced to the left side. (Fig. 3.) The peritoneum was cut at the external edge of the cecum and right colon and

volved the entire right common iliac, the external iliac and penetrated under the inguinal elements. The aorta above the aneurysm was separated from the vena cava and encircled for a longitudinal extension of about 2 inches up to the exit of the inferior mesenteric artery.
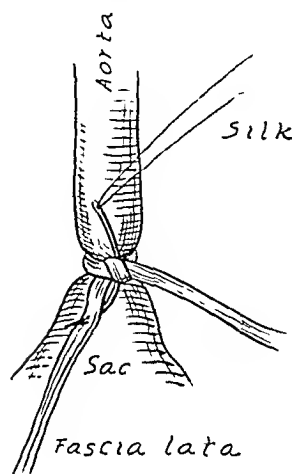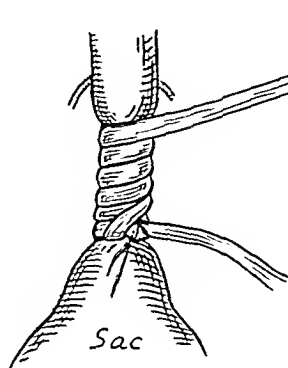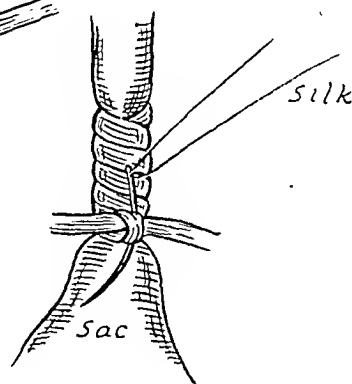
FIG. 7.   FIG. 8.   FIG. 9.

FIG. 7. Third stage of spiral ligation, the fascia lata is knotted and fixed by silk suture.
FIG. 8. Fourth stage of spiral ligation, first layer of fascia lata spiral is performed.
FIG. 9. Fifth stage of spiral ligation, second layer of fascia lata spiral is performed; ligation is complete.

was dissected sufficiently to reach the aorta above the aneurysm. (Fig. 4.) The aneurysm was the size of a two year old child's head. It began at the bifurcation of the aorta and in-

FIG 10. Systolic and diastolic blood pressure and pulse during the operation. The rise in blood pressure corresponds to compression of the aorta with rubber tube and to the definitive ligation of the vessel.

A rubber tube was passed around the upper part of the aorta and clamped with forceps in such a way as to obtain complete occlusion of the vessel. In order to permit such a procedure the assistant pressed the aorta against the spine with his finger in a position parallel to the vessel. (Fig. 5.) Consequently, the pulsations of the sac disappeared. After that test the rubber tube was opened and left in the same place. A strip of fascia lata about 30 cm. in length and about 1.5 cm. in width was removed from the right thigh. After occluding the aorta again with the rubber tube it was easy to perform the definitive ligation. The technic employed (Figs. 3 to 9) was as follows: A thick silk thread was tied around the aorta to smash the endothelium and it was removed afterward. One of the extremities of the fascia strip was passed around the lowest part of the aorta immediately above the aneurysm and was tied with a surgical knot; this was fixed by a silk suture. The free extremity of the fascia was then wrapped around the vessel four times in order to obtain a spiral. Upon reaching the upper part the fascia strip was directed to the lower part thus covering the first layer. It was tied to the other extremity which remained at the lower part, Again a silk suture was used to

fix the fascia. With that technic, a closing ring around the aorta of about 1 inch in height resulted. When the operation started, blood pressure was 120/70; it rose to 150/78 immediately following occlusion of the aorta, at which time the pulse was 140 and respiration 42. At the end of the operation the duration of which was one hour and ten minutes the blood pressure was 110/60. (Fig. 10.)

On the first postoperative evening the blood pressure was 130/70, pulse, 100 and temperature 36.8°c. The patient's general condition was satisfactory. No pulsations could be made out in any of the arteries of the lower extremities. The feet and legs were cool and pale. There was marked diminution of tactile and thermic sensations, complete paralysis of the left lower extremity and paresis of the right lower extremity. The patient was able to move the toes of his right foot but he complained of a numbness and tingling of his lower extremities.

On August 31st temperature was 37°c., pulse, 116 and blood pressure, 130/70. There were no pulsations of any arteries in the inferior limbs. He complained of accentuated pain, principally in the left side, with numbness and tingling. The left lower extremity was completely paralyzed, but he was able to flex his right knee also performing some movements with his right foot and toes. That evening pain and numbness increased considerably in the left lower extremity, especially in the foot. At that time his temperature was 37.2°c., pulse, 112 and blood pressure, 120/80. No pulsations could be made out in either of the lower extremities.

On September 1st sensation had not returned to the lower extremities but he was able to move slightly the different parts of his right leg. Temperature was 37.3°c., pulse, 98 and blood pressure, 120/70. Oscillometric readings at pressure 100 mm. Hg were as follows: right leg, midthigh, 0.1 to 0.2 units; left leg, midthigh, 0; left arm, 4.0 to 5.0 units. The heart was not enlarged and the heart sounds were normal. On September 2nd no changes were presented. Histamine test was as follows: no reaction in either feet or legs; slight hyperemia and pain in both thighs. On September 6th, pain was limited to the left foot and the patient complained of burning and aching (Fig. 11.) On September 7th the aneurysm was about 60 per cent of its original size and no pulsations could be felt in it. On September 14th,

venous pressure was 3.5 in both legs. Urine concentration test was as follows:

Time	Volume	Density
12 p.m.	100 Gm.	1.010
2 "	60 "	1.012
4 "	84 "	1.012
6 "	110 "	1.015
8 "	100 "	1.015
10 "	80 "	1.020
	534 Gm.	

On September 17th oscillometric readings at pressure 100 mm. Hg were as follows: right leg, midthigh, 0.4 to 0.5 units; left leg, midthigh, 0 to 0.1 units; left arm, 5.0 units. Pain and numbness disappeared quite completely. Movements were satisfactory in the right lower extremity and were very limited in the left.

On September 20th a neurologic examination revealed the following: All muscle groups showed greatly diminished power on both sides. Active movements were most difficult on the left side. Deep reflexes of the lower extremities, with the exception of the right Achillean, had disappeared. Cutaneous plantar reactions were abolished on the left side and were present on the right. Cremasterin reactions had disappeared. Abdominal reflexes were present. Deep sensation was normal. Thermic sensation was diminished at the inner sides of both legs and feet. Pain sensation was reduced at the outside of the feet and legs. Sphincters were perfectly continent.

On October 17th the aneurysm was only 40 per cent of its original size and no pulsations could be felt in it. In the right lower extremity faint pulsations could be felt under the inguinal band and in the popliteal region. No pulsations could be felt in the left lower extremity. Oscillometric readings (at pressure 100 mm. Hg) were as follows: right leg, midthigh, 0.5 to 1.0 units; left leg, midthigh, 0.2 to 0.4 units; left arm, 5.0 units. Pain and all uncomfortable sensations had disappeared completely. Every movement of the right lower extremity was possible but in the left leg there were only very slight movements. He could stand quite well and he was able to walk with the aid of a cane. The temperature of the right leg was normal but the left was slightly cool.

Believing at that time that the collateral blood had had sufficient time to develop, we determined to take an aortography. On October 18th the aortography was performed as follows: Spinal anesthesia with 150 mg. scurocain was administered. The contrast stain which was showed that the left leg was thinner than the right. The left foot was in slight equinism causing some trouble in the gait. Neither mass nor pulsation could be felt in the region of the aneurysm. Heart size and sounds were normal. There were pulsations in all arteries of the
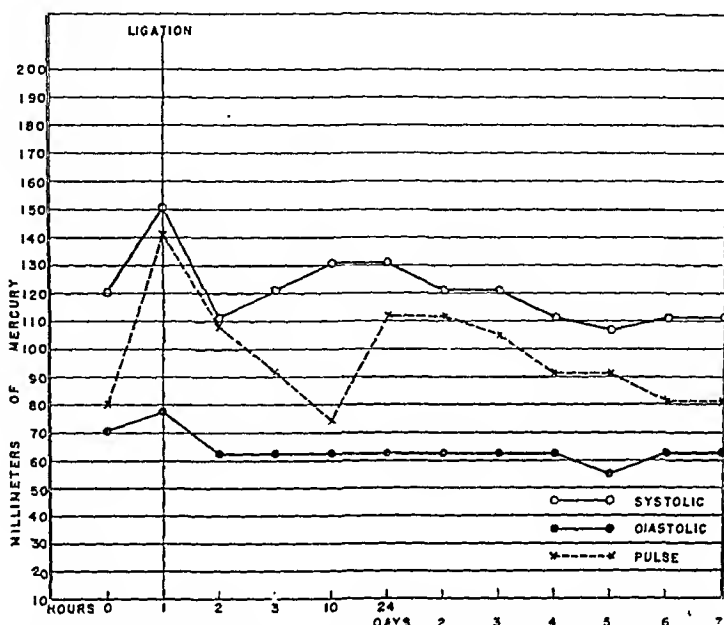
FIG. 11. Systolic and diastolic blood pressure and pulse during the first seven days after operation. The variations in blood pressure and pulse are similar to those shown by any laparatomy.

employed was 40 cc. of a solution of 100 per cent of natrium iodatum. The injection was made with an 18 cm. needle introduced into the aorta through the inferior left costo vertebralis angle. The machine of Reynaldo Santos was employed to obtain a pressure of 4.5 pounds. At the moment of injection the patient complained of severe pain in the abdomen and thorax lasting a few seconds. The picture obtained showed total interruption of the aorta and a very rich collateral blood supply. (Fig. 12.) On October 30th the patient was discharged from the hospital; he was able to walk without help.

On March 12, 1945, the patient came back to the hospital. He had been at work since January, 1944. His general condition was excellent. His weight had increased 45 pounds, being actually 153 pounds. (Figs. 13 and 14.) He could walk well, complaining only of a diminution of the power of the left leg and stating that the left foot became cold more easily than previously. On such occasions he felt slight pain and numbness. Examination

lower extremities but none could be made out in the left dorsalis pedis.

Neurologic examination showed the following: All of the deep reflexes of the lower extremities were present and normal except the left Achillean which was abolished. Abdominal, cremasterin and plantar reflexes were normal. All sphincters were active. Potentia coeundi was normal. There was slight thermic hypocsthesia in all of the left leg. The neurologic changes were certainly the result of a deficient blood supply of the nerves of the lower extremities, principally in the left side. Oscillometric readings at a pressure of 80 mm. Hg were as follows: right leg, midthigh, 2 units; left leg, midthigh, 1 unit; left arm, 5.5 units. At 100 mm. Hg the readings were as follows: right leg, midthigh, 1.5 units; left leg, midthigh, 0.5 units; left arm, 5 units.

We last saw the patient on February 4, 1947, three and one-half years after the operation. He was working and did not present any troubles or problems.

Fig 12. Aortography forty-nine days after ligation of the aorta, showing interruption at the level of the third lumbar vertebra and the appearance of collateral circulation.

COMMENT

The author is convinced that the most important factor in the cure of aortic aneurysm is the proximal occlusion of the vessel. Perhaps it may not be sufficient in some cases but no one can contest its importance because a simple complete occlusion has been performed only twice upon human beings (Brooks and Prudente) and the aneurysm was cured each time. Otherwise, subtotal occlusion itself may be sufficient as in the operation performed by Matas.

It is not my wish to discuss here the methods of chemical irritation or "wiring." I prefer the methods of external compression of aneurysmorrhaphy. As I see it the material, in order to be used in the ligation itself, must be well tolerated by the organism, must be pliable and of moderate elasticity in order to compress the artery sufficiently. The metallic bands must be abandoned because of their

rigidity which causes rupture of the vessel as one can prove in all the cases in which they were used. The rubber tubes are also hard which tend to provoke ruptures and secondary aneurysms in the patients in whom they were used. (Fig. 15.) Silk, catgut or whatever other material is used in the form of thread also cause rupture of the vessel because of the pressure exerted upon a very restricted area of the wall. Therefore, the importance of tape or bands of flexible and lightly elastic material is clear. I believe that cotton tape as well as fascia lata lends itself to ligatures if it is used adequately. Monahan[37] expresses it very well in his recent work in which he says, "It would seem that proximal obliteration could very well cure aneurysms if material or a method could be obtained whereby healing of the vessel by fibrosis would occur without weakening of the vessel by the pressure of an occlusive band."

To my way of thinking there is no reason to discuss preferences for cotton tape or fascia lata. The important thing is to use them in such a way as to cause occlusion of the vessel according to the laws of nature which is to form a clot that will transform itself into fibrous tissue. At the same time it is necessary that the ligature not only does no damage to the circulation of the arterial wall (vasa vasorum) by causing ruptures but also strengthens the wall itself. I believe that the ligature applied in a spiral form after first destroying the intima of the vessel with a temporary silk ligature definitely solves the problem of total occlusion of the aorta because: (1) The crushing of the aorta with silk causes a rupture of the intima, a condition necessary for the coagulation of blood inside the vessel. As the silk thread is only temporary there is no danger of necrosis of the wall. (2) The spiral is a very elastic system with pressure distributed along a good extension of the wall of the aorta; therefore, the wall cannot be cut through so readily. (3) The expansile pulsation of the aorta works only against the upper

13

14

Fig. 13. Photograph showing patient forty days after operation. His weight was 110 pounds.
Fig. 14. Photograph showing patient eighteen months after operation. His weight was 153 pounds.

rings of the spiral in such a way that if the upper rings open the lower will close. Therefore, there is a guarantee for primary occlusion of the vessel. (Fig. 16.) (4) The lumen of the vessel at the level of the covered area through the aponeurosis acquires the form of a cone, a favorable condition for formation of a clot and its rapid organization. (Fig. 16.) (5) The double layer of the aponeurosis which covers the vessel strengthens the wall.

Admitting the fact that the total ligation of the aorta may be sufficient to cure the aneurysm of this vessel, we see in the first place what the indications or contraindications are and under what conditions it may be applied. Second, we see when it may be applied in one operation along and if it is possible to effect it gradually.

Total ligation is dangerous when the circulation of the inferior limbs is poor due to lesions of the arteries. This is more common in people past the age of fifty. In these patients the danger of gangrene is great because the collateral circulation does not find sufficient channels. The supplementary circulation is formed rapidly after ligation of the aorta because the pressure upon the capillaries and collateral vessels is very great. In older people lesions of the collateral vessels also obscure the prognosis. Control of collateral circulation may be made through preoperative aortography; however, it is not always possible to make conclusions in this respect. In the two cases in which ligation caused gangrene of the inferior limbs (Watson and Morton-Scott) we only know the data relative to the patient of Morton and Scott's. This patient was fifty-two years old and suffered from a ruptured aneurysm with retroperitoneal hematomas. This is a fact contrary to the thesis of Matas[26] who maintains that: "It would seem that, in large and leaking aneurysms with progressive subperitoneal extravasation, the collateral circulation is well established."

Treatment of patients in whom there is bad circulation in the inferior limbs is an occlusion performed in two stages making first, a simple partial ligation and second, a spiral ligation. The heart seems to support perfectly the supercharge imposed upon it. It is evident that when there is a deficiency of the myocardial muscle ligation is contraindicated. The first case

OCCLUSION BY LIGATION	RE-ESTABLISHMENT OF LUMEN	RUPTURE ABOVE POINT OF LIGATION	SECONDARY ANEURYSM
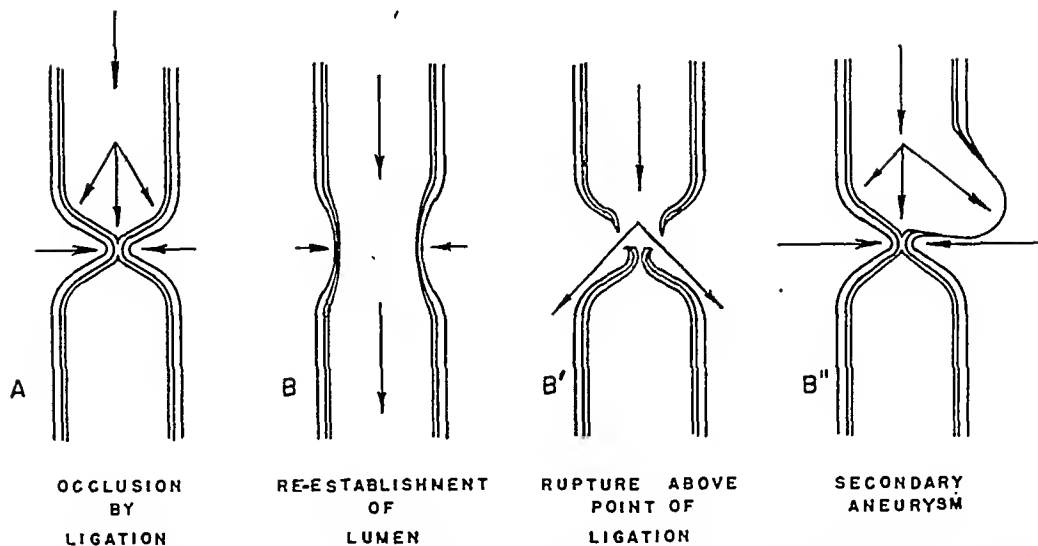
FIG. 15. Usual ligation with only a ring of different materials. Pressure in the aorta is very strong. If resistance of ligature is not sufficient, permeability of the vessel can be re-established (B). If the ligature resists, the arterial pressure acts against the wall of the artery in a line corresponding to the superior edge of the ligature resulting in its rupture (B′) or a secondary aneurysm (B″).

OCCLUSION BY LIGATION	DEFINITIVE OCCLUSION BY LIGATION
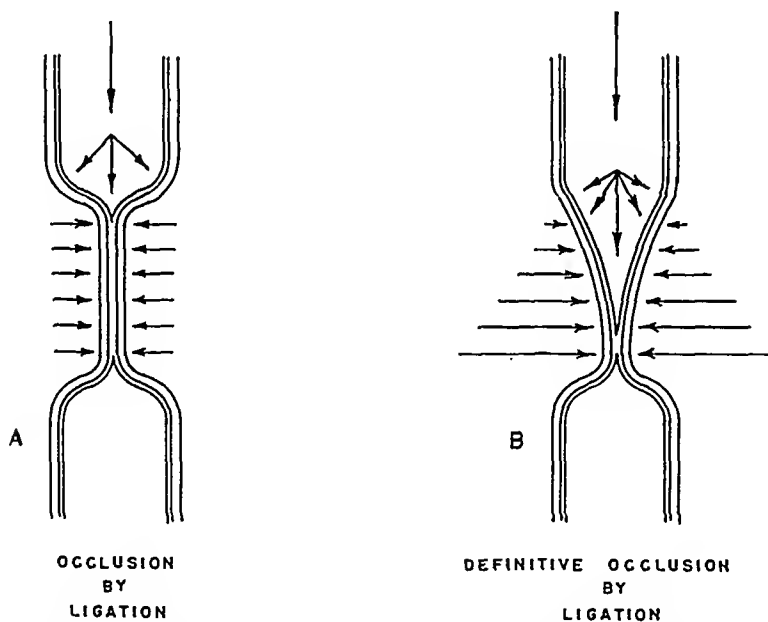
FIG. 16. Spiral ligation with fascia lata. Resistance of the ligature is distributed to a large extension of the wall of the artery (A), but being less than the aortic pressure gives up in the superior part, increasing the resistance in the inferior one. The lumen of the vessel at the level of ligature acquires a conic form, facilitating the coagulation of blood and the formation of fibrous tissue.

reported by Bigger shows the gravity of these instances very well. The level of the ligation is of fundamental importance. Good results were always obtained below the inferior mesenteric, one of them (Vaughan) being distal in relation to the aneurysm. Perhaps the solution to higher aneurysms may be ligation in two stages or use of other methods, "wiring" for example. Finally, contraindication is positive when multiple aneurysms exist, corresponding to what Annes-Dias[41] called "aneurysmatic disease" in one of his lessons on aneurysms of the abdominal aorta in which he showed a patient with nine aneurysms.

In regard to the inconveniences of a ligation of the aorta they are exclusively represented by the functional failure of the inferior limbs due to lesions of the nerves produced by the insufficiency of the blood supply. In the three cases in which total occlusion was performed (Brooks, Bigger, and Prudente), these phenomena were intense but always showed accentuated improvement followed by perfect functional restoration, allowing the patient to return to his activities. In the author's case there was no trouble with the renal function as was proved by the tests of the concentration of urine. Increase of arterial pressure which immediately follows ligation of the aorta is transitory and does not threaten the life of the patient. The same may be said in regard to the increase of frequency of pulse and respiration caused by ligation. It seems to me that these phenomena must be attributed to an irritation of the periarterial sympathetic nerves.

From observation of the case presented one may draw the following conclusions:

(1) A fascia lata ligature in spiral form effects total and definitive occlusion of the abdominal aorta.

(2) The troubles caused by ligation are of neurotrophic order due to the deficiency of the blood supply and they disappear little by little.

(3) Total and definitive occlusion of the aorta above an aneurysm of the same vessels is able to effect cure of the aneurysm.

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USE OF A CONTINUOUS NON-ABSORBABLE BURIED SUTURE THROUGHOUT IN OPERATIVE PROCEDURE

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THE lack of unified opinion as to what constitutes an ideal suture material and technic serves as a background for this presentation. The multiplicity of the routines recommended would appear to be, in itself, evidence of the absence of universal acceptance of any one as superior.

As early as 500 b.c. Susruta[7] used cotton for closure of joint and abdominal wounds. Probably the most outstanding advocate of non-absorbable sutures in more modern surgery was Halstead.[4] His successful experiences with silk are well known and his tenets have since served as basic rules for others using silk and also other non-absorbable materials. Because of their importance these tenets are reviewed. They are (1) the use of interrupted sutures; (2) the use of a fine suture material since the material need be no stronger than the tissues it re-apposes; (3) the employment of transfixion sutures to prevent slipping of ligatures and to permit the use of fine sutures; (4) the use of a greater number of fine sutures rather than a few coarse ones; (5) the advice against bridging a dead space with a suture; (6) the avoidance of a combination of absorbable and non-absorbable suture in the same case.

The first departure from Halstead's silk principles was in the use of other non-absorbable materials. Ginkovskiy[3] was one of the earliest modern surgeons to advocate other substances when, in 1936, he reported the use of cotton, first in animals and then in human beings. Other materials which have been used successfully by other surgeons include linen, chrome alloy wire, tantalum, etc.

A revival of interest in cotton was probably most stimulated by the splendid work of Mead and Ochsner.[4] They exploded the "foreign body reaction" theory and showed that cotton not only produced less tissue reaction than linen, silk or catgut but that it also retained its tensile strength within tissues longer than did these other materials. In this work with cotton the tenets of Halstead were recommended as policy, allusion being made to difficulties having arisen when they were disregarded.

The earliest noted departure from the interrupted method of the Halstead tenets in the use of non-absorbable material was by Taylor[5] in 1941. He estimated that in using his technic with cotton, his operating time was reduced 30 to 50 per cent. His method included the following: (1) the use of a single size thread, doubling it where necessary; (2) the use of a continuous suture in gastrointestinal and peritoneal closure; (3) the use of a transfixion ligature only when indispensable to hemostasis; (4) a reduction in the number of interrupted sutures by use of figure-of-eight stitches in fascia and by use of mattress figure-of-eight retention sutures in the skin and fascia. These latter also were said to eliminate necessity for interrupted suture closure of the subcutaneous fatty tissue.

Others have used part interrupted and part continuous cotton sutures. Brooks, Ashley and Thorstad[6] in 1942 followed Halsted's interrupted technic except that continuous cotton was successfully used on the peritoneum for quick closure when the spinal anesthetic was wearing off.

Reference to recent experimental and practical studies upon suture material reveal that cotton has gained a position of increasing popularity and acceptance. This would appear to be due to the fact that

it is inexpensive, pliable and produces less tissue reaction. It has a satisfactory tensile strength which is retained within the tissues. It has a high coefficient of friction and possesses stability on exposure to heat and moisture, hence is readily sterilizable. It possesses none of those disadvantages voiced against catgut, namely, difficulty of sterilization, allergic sensitivity, variable absorbability and deleterious effects of chemicals.

In considering the subject of materials and methods of suture, it occurred to the writer that doubtless there are occasions in surgical practice in which all are agreed that speed might be a contributory factor in a successful operative result. This would appear to be particularly true in instances of multiple war or industrial casualties in which time devoted to each case should be limited in order that early surgical attention may be given to as large a number of patients as possible. Using the more time-consuming interrupted technic would render such an achievement more difficult.

It was thought that even though it would depart another step from Halsted's tenets, operative time might be reduced and simplicity gained by combining the use of an increasingly more acceptable material with a technic of expediency; hence a continuous cotton suture has been used throughout in operative procedures.

Before discussing the subject further, however, I should like to refer to disadvantages that have been voiced against cotton as a suture material. First, as is the case with silk, it is said to be more difficult to handle when one has been accustomed to a coarser, less pliable material such as catgut. This awkwardness, however, was soon overcome in my experience with the practice afforded by consistent use in a few operations. It is also stated that its initial tensile strength is less than silk, linen or catgut. Again this disadvantage was overcome with practice in its use and is a factor discouraging crushing, necrosing reappositions of tissue which most surgeons have probably been guilty of executing on occa-

sions when using material with a higher initial tensile strength. It is variously stated that cotton, as is true with all non-absorbable material, is more prone to result in sinus formation. In this series of cases, however, high incidence of sinus formation has not been noted. Again, there has been an expressed reluctance to use continuous cotton because in so doing, theoretically, a larger quantity was necessary with corresponding increase in foreign body reaction and increased likelihood of sinus formation. In a simulated wound closure in an 8-inch wound, using small bites into margins, an interrupted technic using No. 24 cotton was employed. These interrupted sutures were placed 1 cm. apart. After closure the sutures were removed and weighed. Then an incision of the same length was closed with a continuous suture from the same No. 24 spool and this suture removed and weighed. It is worthy of note that the cotton used in the continuous suture technic weighed less than that used in the interrupted technic. The weights were 19.5 mg. for the continuous and 22.5 mg. for the interrupted.

Though appreciative of variations in individual dexterity, it is here noted that the time required for closure of this 8-inch simulated wound using an interrupted technic required a little more than twice that required using the continuous suture.

Technic. Two different sizes of cotton were used. A single size, as suggested by Taylor[9] was not employed because cotton was also used for ligatures and a much smaller size (No. 70) has been used for this purpose. Again, personal experience revealed the technic to be simpler when a single larger suture was used rather than the smaller variety doubled. Though cognizant of the notable work of Localio and Hinton[5] on the varying tensile strengths of cotton from different manufacturers, no effort was made to use any particular brand, having obtained several different types in random purchasing at dime and department stores. The method of sterilization was similar to that described else-

where[6] namely, that of boiling after winding onto rubber tubing. Square knots were used throughout and no slipping or untying was noted when sutures were cut close to knots.

The technic herein outlined has been used in 187 cases. Table 1 indicates the size of continuous cotton employed and also the number of closures accomplished on various tissue layers. There was no mortality in this series of 187 cases. Wound complications encountered in the series are indicated in Table 11.

Pertinent to these wound complications, the following comments are made. As indicated in Table 11, on several occasions fluctuation developed in the wounds. These patients had no systemic reaction. In several instances the amount of fluctuation was rather conspicuous and, according to concepts based upon previous experience with catgut, would have either evacuated spontaneously or would have required drainage. These fluctuant wounds were left alone, however, and fairly rapid and eventually complete absorption took place. In three of these seven cases, there appeared to be a definite sanguineous component. In the other four serum accumulation alone was presumed to be present.

The three wound abscesses occurred in patients with appendicitis without perforation. In one instance the abscess followed use of the larger No. 12 cotton which was replaced by the smaller No. 24 after use in three cases. This one case also accounted for one of the instances of sinus formation. The other two abscesses healed without sinus formation.

Sinus formation was considered to be present in the two cases when healing was not complete four weeks postoperatively. One sinus case followed wound abscess as noted and the other was preceded by hematoma requiring evacuation. In both cases healing was prompt after removal of the suture. In neither case was it necessary to reopen the wound. A mosquito hemostat was used and the long single strand of continuous suture was located with much greater ease than previously experienced

in "fishing" for an offending interrupted non-absorbable suture. Thus far, the removal of the fascial suture (size No. 24 identifying it as such) has been sufficient to permit healing in the patients developing sinus. It is presumed that healing in the

TABLE I
SIZE OF CONTINUOUS COTTON USED AND NUMBER OF CLOSURES OF VARIOUS TISSUES ACCOMPLISHED

Tissue Approximated	Size Used			No. of Closures Accomplished
	No. 12	No. 70	No. 24	
Peritoneum..............	..	x	..	160
Internal oblique and transversalis, (in McBurney incision)...............	..	x	..	123
Deep cervical fascia (thyroidectomy)............	..	x	.	5
Tunica vaginalis.........	..	x	..	9
Synovial membrane......	..	x	..	6
Anterior sheath of rectus	..	..	x	27
Linea alba.	..	..	x	16
Aponeurosis external oblique................	..	..	x	123
Ligament closure (after arthrotomy)............	..	..	x	7
Deep fascia..............	..	..	x	2
Aponeurosis external oblique (first three cases)..	x	..	...	3

TABLE II
WOUND COMPLICATIONS IN 187 CASES

Complication	No. of Cases	Percentage
Wound disruption..................	0	
Subcutaneous Hematoma (requiring evacuation)...................	1	0.53
Wounds developing fluctuant (swelling not requiring drainage)........	7	3.70
Wound abscess requiring drainage....	3	1.59
Sinus formation....................	2	1.06

fascial layer was after four weeks relatively complete. Removal of the suture has not been considered then a factor affecting wound integrity.

The following observations were made in this group of cases. A comparatively rapid closure was possible. There seemed to be a definite diminution in pain and tenderness in operative wounds as compared with those closed with any type of catgut closure. It was possible to permit patients to be out of bed much earlier in

convalescence. This could be done because less pain attended efforts to move around and because more confidence was had in the integrity of this wound closure than in that accomplished by use of catgut. In our experience there was a decreased incidence of serum accumulation and hematoma formation as compared with a similar group of catgut closures. The reduction in incidence of hematomas was thought to be due to the fact that when cotton was used slipping of knots and premature absorption of ligatures did not occur as may when using catgut. In this series in which continuous cotton was used a decreased incidence of wound infection as compared to that in catgut closure was noted. In this connection Fisher and Burch[2] observed in reporting the treatment of 1,494 patients with appendicitis that wound infection dropped from 3.4 to 1.1 per cent after substituting cotton suture material for catgut.

Brief reference has been made in the literature to the successful use of cotton as an interrupted suture in the presence of infection. Because it had proved to be a relatively simple procedure to remove a continuous cotton suture if sinus formation did occur, it was decided to employ this closure technic in four frankly infected patients and one potentially infected in this series. In the four patients infected perforated appendix accounted for the infection present. Closure in each was accomplished without drainage. Sulfanilamide was used locally in three of these cases and an oral sulfonamide was given in all four. The potentially infected patient in whom the continuous cotton routine was used was an instance of ruptured duodenal ulcer with copious intraperitoneal spill. Healing by first intention was achieved in both the infected and potentially infected. Obviously, uncomplicated healing in five cases does not constitute conclusive evidence that such success

would attend subsequent attempts. However, experience gained in these cases has suggested the justification for further observation concerning the efficacy of this method.

In summary, a departure from the described previously accepted principles of wound closure is recounted. Speed and ease of application are cited as advantages, of the method. Success of the method, including reduced incidence of wound complications, has suggested its acceptability.

CONCLUSIONS

1. History of non-absorbable suture material and technic for its employment is reviewed.

2. The fact is noted that cotton as a suture material has gained a position of increasing popularity and acceptance.

3. As a routine of expediency the use of cotton as a continuous suture throughout operative procedure is suggested.

4. Possible justification for the use of this method in infected operative cases is mentioned.

5. Results are reported following use of this type of continuous cotton suture throughout in a series of 187 operative cases.

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METHOD FOR SUTURING A SHORT PULMONARY VEIN

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IN most cases pulmonary resection can be performed by the usual method of isolating the vessels and bronchus individually, with separate transfixion and ligation of each vessel on either side of the point of division. This is possible because the length of vessel isolated is sufficient to allow the placing of four sutures.

Occasionally, a pathologic condition is encountered in the lobe of the lung to be removed that prevents adequate isolation of the hilar vessel. This may be too deeply situated to allow the placing of more than a single width of clamp. This picture is seen especially when the lung fails to collapse because of pneumonitis or other rigid diseases lying immediately adjacent to the vessel. In such a difficulty the following method is suggested as a final means of controlling the short pulmonary vein adjacent to such a condition and completing the resection without incurring fatal hemorrhage:

A transfixion suture is placed peripherally as far from the pericardium as possible to control hemorrhage from the pulmonary side. Two clamps are then placed centrally to include a portion of pericardium on either side with one-half of the vessel in each clamp. The vessel is then divided distal to the clamps and the lung displaced laterally. Two interrupted fine silk sutures are then placed one at either side of the mediastinal stump of the vein, central to the clamps, to include a portion of the pericardium with the vessel wall in a transfixion suture. (Fig. 1A.) A continuous suture on a very fine needle is then begun central to the posterior clamp to overlap the interrupted suture. This is continued over the posterior clamp which is then removed and (Fig. 1B) the suture completed with the removal of the anterior clamp after the vein has been completely sutured. (Fig. 1C.)

The advantage of including the pericardium in the suture is to give strength to the thin-walled vein and to prevent the suture from pulling out. Care must be taken that the vein does not retract into the pericardium. This is largely prevented by the initial interrupted retention stitches.
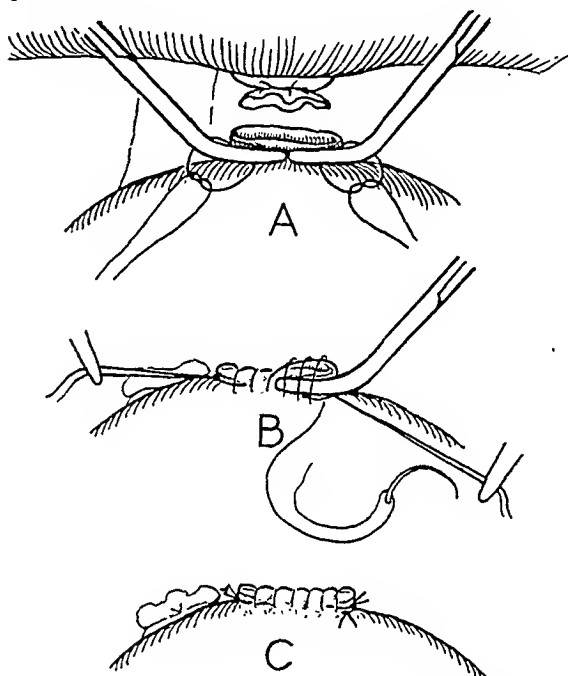
FIG 1. A, shows clamps placed centrally on divided pulmonary vein, including edge of pericardium. Retention stitches transfix pericardium and wall of vein on either side of vessel, B, shows continuous stitch overlapping the retention suture—one clamp has been and the other is about to be removed following completion of running suture; c, completed relationship of interrupted to continuous sutures is demonstrated with pericardium and vein included in both.

I have used this method with success on both pulmonary artery and vein as a means of controlling hemostasis. It eliminates the necessity of opening the pericardium to do an intrapericardial ligation, and it may be a means of assuring the operability of a lobe which otherwise might be considered inoperable. The method is advocated for those cases only in which the usual type of ligation is impossible for the reasons described.

Case Reports

AMEBIC GRANULOMA OF THE LARGE BOWEL

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THIS case illustrates the need for thorough clinical, laboratory and roentgenographic investigation of the colon in the presence of hemorrhoidal disorders with rectal bleeding. So often a simple hemorrhoidectomy has not been the answer to rectal bleeding and the patient still harbors the "bête noir" of our times, malignancy, and other more drastic lesions. This case justifiably erases the time-honored dictum "when in doubt operate." Resections of the colon still carry quite a morbidity and in the hands of competent surgeons a relatively low mortality; yet to operate unnecessarily is quite a costly experience for the patient, economically, functionally and last but not least psychologically. Again what a sad awakening for the chagrined surgeon to have performed a formidable colonic resection only to have the pathologist report "granuloma of the bowel."

The profession should utilize every diagnostic and clinical means at its command. It is only in this way we can more accurately evaluate the problem at hand. Hemorrhoids are innocuous and can wait; bowel malignancies and tumefactions cannot.

CASE REPORT

This patient was first seen by me with a chief complaint of rectal bleeding and hemorrhoids of three years' duration. The family history revealed no tuberculosis, cancer, etc. In 1928 the patient was in the service of the regular army, spent three weeks in the Panama Canal Zone and was stationed at Scoffield Barracks, Hawaii, for a period of two and one-half years. About two months after leaving Panama and while stationed at Scoffield Barracks the patient was operated upon for acute appendicitis with uneventful recovery. There was no history of bloody diarrhea at that time. During the past fourteen years the patient had been well, working as a lineman and cable splicer. His appetite and digestion were normal and there was no weight loss, no diarrhea or bloody stools.

About three years previously this patient began to have rectal bleeding associated with pain and burning sensation or defecation, constipation, protruding hemorrhoids with intermittent abdominal pains lasting three or four days which would pass away. He did not lose weight; his appetite and digestion were normal and he always continued with his work. At this time he saw his family physician who treated the patient for hemorrhoids by the injection method two to three times weekly for five or six weeks, but treatment was discontinued because the patient developed a giant urticaria. No proctoscopic, sigmoidoscopic nor stool examinations were made at this time.

Two years ago the patient had a severe bout of bloody diarrhea lasting about eight weeks. He received no medical attention since he thought he had eaten food which had not agreed with him. Since that time he had occasional abdominal pains, dull aches, associated with mild bouts of intermittent bloody diarrhea and progressively increasing constipation, with no bowel movements for as long as three days. During the latter part of his present illness the abdominal pains simultaneously became progressively worse.

Physical examination revealed a well developed and well nourished white male, forty-one years of age, not acutely nor chronically ill. He complained of rectal bleeding and painful, burning sensation on bowel movements. However, he continued to perform his regular work

until two days prior to hospital admission. His temperature was 98.6°F., pulse 80; respirations 20; blood pressure 138/74; weight 185 pounds. Eyes, ears, nose, throat and neck were normal.

No abnormalities were noted in the chest. Heart sounds were regular and of good muscular quality. An appendectomy scar was well healed. The abdomen was soft with some tenderness in both lower quadrants especially the right. No masses were palpable and there was no spasm or rigidity. The liver was within normal limits; the spleen, kidneys and gallbladder were not palpable. No hernias were present.

Rectal examination revealed external and internal hemorrhoids, with no fissures, pilonidal sinus or dermatitis. Proctoscopic and sigmoidoscopic examinations revealed the following after thorough cleansing of the bowel with enemas and catharsis: mucosa throughout was markedly hyperemic and edematous although no ulceration, masses or obstruction were noted.

The patient was admitted to my surgical service at the New York Post-Graduate Hospital for hemorrhoidectomy on March 8, 1948, for operation. However, on the eve of admission the patient still complained of abdominal pains and examination revealed moderate tenderness in both lower quadrants, especially the right with no spasm or rigidity. The morning of the operation this patient was again examined and the clinical picture of the past evening had not changed. In view of these findings together with the pathologic condition of the mucosa (rectosigmoid) and since the patient was already prepared for operation, a barium colon enema was ordered to investigate the colon more adequately. Needless to say the operation was cancelled.

To my amazement the findings were as noted in Figure 1. Since this patient had been stationed in the Panama Canal Zone and did considerable traveling to foreign ports, a stool examination was next in order. On March 12, 1948, Escherichia histolytica, cysts, Escherichia coli and nana were found. Warm, freshly passed liquid stools presented "motile trophozoites of Escherichia histolytica. Warm specimens repeated on March 15th showed many trophozoites of Escherichia histolytica present but were negative for other ova or parasites.

At this time our x-ray department thought in terms of a malignancy associated with ame-

Fig. 1. The first barium colon enema study on March 9, 1948. This contrast clysma study shows nodular intrusinal defect about the size of a walnut on the medial aspect of the ascending colon about 2 inches above the caput apparently of neoplastic nature.

biasis. However, in view of the good general appearance of the patient, with a red blood count of 4,600,000 hemoglobin 15 per cent, no weight loss, a diagnosis of amebic granuloma was strongly considered. Therefore, a more conservative course and specific therapy for amebiasis was started immediately. The patient was given an adequate amount of emetine and carbarsone. (Fig. 2.) Barium colon enema presented the lesion markedly diminished after two and one-half months of emetine and carbarsone treatment. (Fig. 3.) During this latter period of therapy the patient noticed a progressively lessening of constipation; he had daily bowel movements without catharsis and no bloody diarrhea. Sigmoidoscopic and proctoscopic examinations revealed a normal mucosa.

The patient was operated upon by me at the New York Post-Graduate Hospital on May 26, 1948, for external and internal hemorrhoids with an uneventful postoperative convalescence. Examination in my office on June 25,
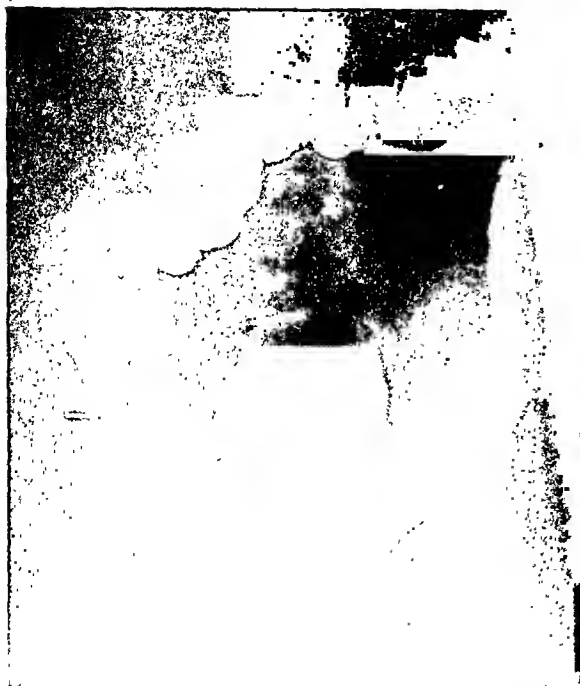
FIG. 2. Examination on April 20, 1948, with contrast enema shows the granulomatous-type lesion on medial aspect of cecum with slight diminution after six weeks of emetine and carbasone therapy.

FIG. 3. Examination on May 28, 1948, with contrast enema (as a recheck) shows a marked dimunition in the nodular granulomatous intrusinal defect on the medial aspect of the ascending colon after two and one-half months of emetine and carbasone treatment.

1948, revealed hemorrhoidal areas practically healed, his general condition excellent, appetite and digestion normal, bowel movements regular and the patient was working daily. Examination of the anorectal, sigmoidal and mucosal areas revealed everything normal so the patient was discharged.

The patient reported to my office on August 5, 1948, stating that he had been working every day with no untoward symptoms. His appetite and digestion were normal and he had daily bowel movements; his weight was 182 pounds. There was no abdominal distress nor any suggestion of bloody diarrhea. Proctoscopic and sigmoidoscopic examinations revealed normal mucosa.

COMMENT AND CONCLUSIONS

A case of amebic granuloma of the cecum is presented which was proved by laboratory studies, barium colon enema and check-up with specific therapy.

Emphasis is placed on the value of thorough investigation of the large bowel in the face of rectal bleeding with bloody diarrhea in the presence of hemorrhoids.

Amebic granuloma may be easily mistaken for malignant growths for they give symptoms, signs and proctoscopic appearances very similar to those produced by carcinoma.

The axiom "when in doubt operate" was disproved in this case. Several cases have been reported in the literature in which an extensive operative procedure was done for malignancy only to find the pathologist reporting amebic granuloma of the large bowel.

Stool examinations for ameba are most important to help substantiate the diagnosis of colonic lesions.

Ameba may occur years after the last recognized attack of dysentery.

In amebic granuloma of the rectum careful observation on proctoscopic examination, biopsy and finally the identification of Endameba histolytica established the proper diagnosis. On the other hand, in some cases the ameba may be incidental findings to carcinoma; hence the need of combining the various diagnostic procedures in order to minimize errors in diagnosis.

The recent available literature has been reviewed. Most cases have been diagnosed carcinoma. They can develop in treated and inadequately treated cases. Intensive antiamebic treatment may result in cure. The examination of stool for ameba after the tumor develops is usually negative.

Most of the patients operated upon die of peritonitis. Cancer may develop in some instances.

Amebic granuloma is localized most frequently in the cecum and the flexures of the colon as pointed out by Howard, Gunn and others but occurs also in the rectum. It is slow in developing and occurs in untreated or inadequately treated patients.

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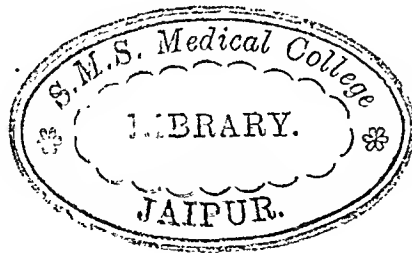
CHRONIC THYROIDITIS

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CHRONIC thyroiditis from the time of its discovery has been the subject of much theorizing and investigation. The original report on the subject was by Reidel in 1896. Because of the characteristic "iron hardness of the gland's consistency" he called it "Eisenharte strumitis." Subsequent to this article several authors from different countries reported clinically similar cases but under varied nomenclature.

Hashimoto in 1902 reported four cases of thyroiditis. He called his cases "struma lymphomatosa." At the time he believed that his cases were clinically and particularly pathologically different from Reidel's struma. The main difference, as the name implies, was the unusual number of lymphocytes with true germinal centers invading the gland.

Following the appearance of Hashimoto's article two schools of thought developed. One group sponsored by Ewing believed that both pictures described by Reidel and Hashimoto were just steps in a progressive degenerative process. A second group believed that both types of strumitis differed both clinically and pathologically and were distinct entities.

Of late there have been many excellent papers and case reports of both types. When one reviews the literature, three facts stand out: (1) Chronic thyroiditis of either type is a degenerative process. (2) A careful history and clinical work-up discloses that there is a distinct difference in the patient presented with Reidel's struma as contrasted to Hashimoto's struma. (3) Postoperative follow-up studies have not been reported in any detail.

It is true that at first many of these differences did not present themselves until after surgery when a more careful recon-sideration of the clinical picture was studied. But, of late, more case reports appear in the literature with a careful history and a detailed clinical work-up, and a preoperative diagnosis that has been confirmed at surgery and substantiated by the pathologist. In short, men who see a fair amount of thyroid work are beginning to spot these cases and diagnose the type of struma accurately.

From the standpoint of etiology of these two types of struma investigation continues. DeCourcy in two recent articles calls attention to what he calls perithyroiditis and believes that this is a true clinical entity with an acute onset. Included in the symptomatology are fevers of varying degree, often associated with chills, pain or other discomfort of the thyroid region, absence of visible inflammation and persistence of tenderness in the lobes after other symptoms have subsided.

DeCourcy emphasizes that the surgeon seldom sees Reidel's struma until the acute perithyroiditis has subsided. This is undoubtedly true. However, Case, in 1943, reported two cases of Reidel's struma. The history and clinical picture follows closely DeCourcy's idea of perithyroiditis, namely, sudden onset of fever, chills and thyroid tenderness. Both patients gave a history of a previous throat infection or a series of throat infections. Case's report was concerned more with the presence of neurotic symptoms bordering on a psychosis. He did not specify any idea of a perithyroiditis.

In 1929 McCarrison reported experimental work on rats fed on a diet of American white flour, meat residue, olive oil, salt mixture and water. He was able to produce goiters as early as seventy-five days and as late as 165 days after beginning the experiment that pathologically resembled s.

lymphomatosa. He suggested that the occurrence of the disease in humans might be on a basis of a diet deficient in vitamins, poor in carbohydrates, proteins, and fats and a scarcity of fresh fruits and vegetables.

A review of reported cases illustrates the different clinical and pathologic aspects of Reidel's struma and s. lymphomatosa. In women s. lymphomatosa is found in 90 per cent of the cases. There is usually a goiter history of three or four years with actual symptoms of twelve to sixteen months. Both lobes are involved and approximately 75 per cent of the patients develop hypothyroidism following surgery.

In Reidel's struma sex is not an outstanding characteristic and the average age is lower than that of patients with s. lymphomatosa. Symptoms are present for an average of six to seven months and, as previously pointed out, the picture of perithyroiditis may present itself. About 75 per cent of cases are of unilateral thyroid involvement and only a small percentage (about 26 per cent) develop hypothyroidism postoperatively. When one has palpated a Reidel's struma, one will always remember the extreme hardness of the gland. S. lymphomatosa is more resilient to palpation and follows more the type of colloid goiter. Patients with this type of struma present a typical squarish appearance of the neck. Both types may cause dyspnea, dysphagia and a feeling of tightness about the neck. Patients with Reidel's struma (following surgery) tend to improve rapidly, whereas patients with s. lymphomatosa have a lengthy convalescence with hypothyroid symptoms.

In s. lymphomatosa the enlargement of the gland is intracapsular and the gland is not adherent to surrounding structures except occasionally to the trachea. The consistency is firm and the gland cuts with increased resistence. The tissue is pinkish-white in color and definite trabeculae can be seen. Microscopically, although some fibrosis is present, the characteristic picture is that of a diffuse lymphoid infiltration between the acini. Numerous secondary lymphoid follicles are present and these may be very large in size. The lymphocytic infiltration varies but is most marked in the interacinar tissues. In the dense portions of lymphocytic infiltration the acini are compressed and atrophic. The epithelial cells of these atrophic acini are peculiarly large, acidophilic and have an increase in cytoplasm. They are similar to those in degenerative processes.

In cases of goiter with symptoms of hyperthyroidism, principally those who have taken much iodine, there is found lymphocytic infiltration and even follicle formation, but always in the presence of acinar hypertrophy.

Reidel's struma has a tendency to become fixed to the neighboring structures. Occasionally there is a concomitant cervical cellulitis. The gland is hard; on multiple sections the cut surfaces present nothing resembling the normal architecture of the thyroid gland. The surface presents a yellowish-gray appearance with the yellow predominating and of an almost homogeneous structure. On closer examination one finds a white net-like system of tendrils separating small lobules of firm yellowish-gray tissue.

Microscopically, the characteristic picture is one of fibrosis. This may vary from an increase in the interacinar and interlobular connective tissue to complete replacement of the parenchyma by dense connective tissue. There may be some lymphocytic infiltration. Giant cells are found usually in the region of degenerating acini. These cells are quite characteristic of Reidel's struma. Goetsch in 1940 proved that these cells originated from degenerative changes in the follicular epithelial cells which lose their cellular identity and fuse with their neighbors to form the giant cell.

The two cases reported in this paper were seen by the author in 1941. They are typical both clinically and pathologically of chronic thyroiditis known as Hashimoto's and Reidel's strumas. The patients were residents of nearby communities and postoperative follow-up studies were con-

venient to all. I became very much interested in studying the postoperative course in these patients, particularly over an extended period of time. Both patients were examined physically and basal metabolic estimations were computed every three months over a period of four years. The case histories, operative procedures and follow-up results are presented.

CASE REPORTS

CASE I. A. T., female, forty-nine years of age of Italian extraction, was referred to us in February, 1941, with a diagnosis of possible malignancy of the thyroid. The presenting symptom was sore throat with difficulty in swallowing, increasing in severity for the past two years. The history (both recent and past) was very difficult to obtain because of language barriers. The patient was born in Sicily and had been a resident of this country for ten years. She had had an abdominal operation five years ago, the nature of which was difficult to ascertain. Her menstrual history was negative. There had been three children in the family; they were all dead and the cause was unknown. No family history was obtained.

The patient was of medium size and very apprehensive, complaining constantly of soreness and thickness in her throat with difficulty in swallowing. She had seen numerous physicians who had prescribed the usual throat procedures with no improvement. The patient wore glasses and had normal pupillary reactions. Eye grounds were negative.

There were no pathologic findings in her ears, nose or throat. In her neck there was an indurated, enlarged, tender left lobe of thyroid that was not freely movable. There was some induration on the right side but this was not as pronounced as the left. Examination of the vocal cords by the Nose and Throat Service disclosed no pathologic condition. The lungs were resonant throughout. There was some enlargement of the heart to the left. No murmurs were heard. Blood pressure was 150/80. There was an old midline abdominal scar; otherwise the abdominal examination showed negative results. There was gross tremor of the hands; otherwise, the extremities were negative. The reflexes were hyperactive.

Laboratory examination revealed the following: Urine: Straw colored and clear; albumin, negative; sugar negative; specific gravity,

1.019; microscopic, few epithelial cells per high power field. Blood: hemoglobin, 87.4 per cent; red blood cells, 4,484,000; white blood cells, 6,400; polymorphonuclears, 70 per cent; lymphocytes, 28 per cent; monocytes, 2 per cent. Blood Wassermann, negative; blood sugar, 130 mg.; blood non-protein nitrogen, 25. Basal metabolism rate, −10 per cent.

The working diagnosis at this time was a possible malignancy of the thyroid.

The patient was operated upon on February 14, 1941, using avertin as a basal and a mixture of gas-oxygen-ether. The usual low collar incision was made and the skin flap dissected free. The prethyroid muscles were incised and dissected free. The prethyroid muscles were incised and dissected with difficulty from the thyroid gland. There were numerous bands of firm adhesions between the thyroid gland and the muscles. The left lobe was enlarged to about the size of a peach. It was firm and grayish-red in color. There was moderate enlargement of the right lobe with some consistency.

A subtotal thyroidectomy was done. There was very little bleeding. The cut surfaces presented nothing resembling the normal architecture of the thyroid gland. It was of a yellowish-gray appearance with the yellow predominating and of an almost homogeneous appearance. However, a white net-like system of tendrils separating small lobules of firm yellowish-gray tissue was noted.

The pathological report showed that the specimen consisted of two segments of thyroid tissue partially covered by a thick capsule. The cut section showed homogeneous structure; the tissue was dull yellow with bands of white suggesting scarred thyroid with little or no colloid.

Sections showed thyroid tissue covered in places with a thick fibrous capsule and containing such fibrous tissue running loosely throughout the gland. In some areas the fibrous tissue appeared to be attempting to form small nodular masses. The tissue was diffusely infiltrated with a large number of giant cells and lymphocytes disrupting and causing atrophy of many of the acini. (Fig. 1.)

Diagnosis: Chronic thyroiditis (Reidel's struma).

The postoperative convalescence was uneventful and the patient was discharged February 25, 1941. At this time she weighed 114 pounds and the basal metabolism rate was −10 per cent. The patient was rechecked

in April, 1941 and her weight was 120 pounds and the basal metabolism rate was —15 per cent. She had no complaints. Her clinical course was as follows:

	Weight	B.M.R.
July, 1941	129	—18
November, 1941	130	—20 1 gr. of thyroid extract twice a day
February, 1942	135	—14
June, 1942	135	—10 1 gr. daily
November, 1942	137	— 8
February, 1943	135	— 5 No thyroid extract
June, 1944	135	+ 4
October, 1944	136	— 2
January, 1945	137	—+ 5
July, 1945	135	—+ 5

The patient had no complaint at any time during the lengthy follow-up period. She emphasized at each visit how "strong" she felt and how she could do all her housework without having "pain in her throat." As the clinical course indicates there was a transient period of hypothyroidism that was adequately controlled with medication.

CASE II. H. M., a young girl eighteen years of age of Ukranian extraction, came to the Thyroid Clinic of the Troy Hospital, June 27, 1941. The chief complaint was a "swelling of the neck" of four years' duration. This swelling was slowly but progressively increasing in size. Hoarseness had been present for the past year. The tone of her voice was that of a forced harsh whisper. During this time interval she thought that her general health was unimpaired. The essential points in her past history were measles and whooping cough in her childhood. The patient stated that she had diphtheria about five years ago that was followed by a tonsillectomy about four years ago. Catamenia was established at the age of fifteen. There were no menstrual disturbances. The parents were alive and in good health. There were seven other children living and well. There was no history of familial disease.

The patient appeared to be a well nourished and well developed young girl with a pronounced bilateral, uniform swelling in the thyroid region. She was very slow acting and speaking. Her weight was 107 pounds, pulse 96 per minute, respirations 18 per minute, temperature 98.6°F. and blood pressure 115/65. The skin was warm and moist and the hair seemed to be of normal texture.

The scalp examination was negative; The
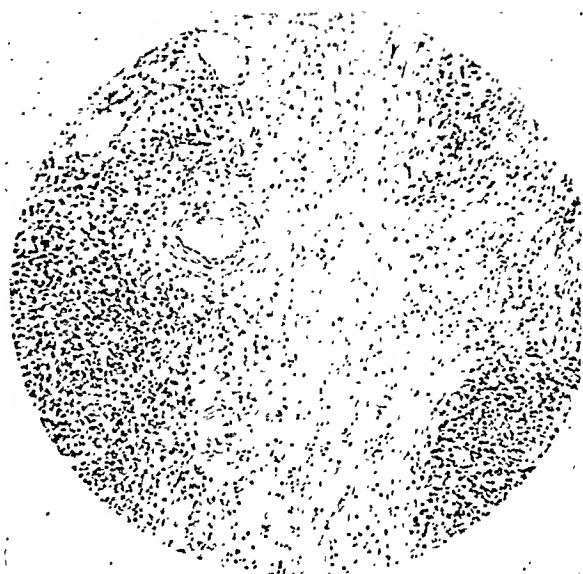
FIG. 1. Photomicrograph from Case 1 showing widespread invasion of connective tissue.

pupils were equal and regular in size and reacted normally to light and accommodation. No exophthalmos was present; the eye grounds were normal. Examination of the ears was negative. There was a nasal septal deviation to the left and the mouth and nasaopharyngeal region were negative. Vocal cord examination showed no pathologic condition to be present. In the neck there was a symmetrical bilateral enlargement of the thyroid gland about four times the normal size. It was very indurated and there was tenderness on manipulation, particularly on the right side. The size of the gland gave a squarish appearance to the neck. No cervical adenopathy was present. The lungs were resonant throughout and there was no ausculatory evidence of a pathologic disorder. The heart was found to be within normal limits as to size and there were no murmurs or rhythm abnormalities. Examination of the abdomen and the genitals were negative. Laboratory examination disclosed the following: Blood Wassermann, negative; blood sugar, 110 mg. per 100; blood non-protein nitrogen, 25; creatinine, 1.1; uric acid, 12; basal metabolism rate, —15. Hematology: Hemoglobin, 82 per cent; red blood cells, 4,250,000; white blood cells, 7,850. Blood smear: Polymorpholucnears, 78 per cent; lymphocytes, 18 per cent; monocytes, 2 per cent; basophiles, 2 per cent. Weight: 118 pounds.

Diagnosis: Colloid goiter with pressure symptoms.

The patient was operated upon on July 10, 1941, using avertin 45 mg. per Kg. of body
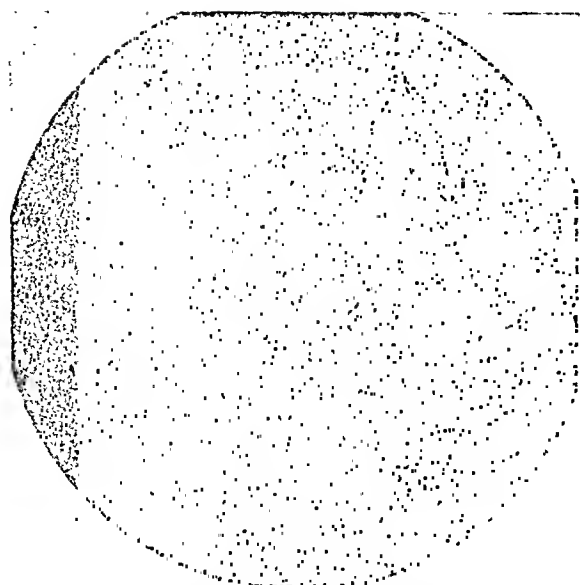
FIG. 2. Photomicrograph from Case II showing widespread invasion by lymphocytes and acinar atrophy.

weight as a basal and a mixture of nitrous oxide gas and ether. The usual low collar incision was made and the gland exposed. The contour of the gland had been preserved in spite of the evident enlargement. There were a few adhesions laterally to the strap muscles. The gland was very firm and its appearance was rather grayish. There were no nodules seen. Both superior poles were ligated and a subtotal thyroidectomy was performed.

Much to our surprise we found that the gland was very avascular, the cut surface was very irregular and the gland itself cut with quite a bit of resistance. Cross sections at the table showed a firm, uniform, opaque homogeneous structure.

There was a diffuse infiltration of the thyroid parenchyma with lymphoid tissue. This was of such a marked degree that the acinar structures were obscured and indistinct. The lymphoid tissue consisted for the most part of small mature lymphocytes although occasional hyperplastic germinal centers containing large lymphocytes were present. In the background small round to ovoid thyroid acini were observed. They were lined by a single layer of low columnar epithelium and were either devoid of colloid or contained scant amounts. (Fig. 2.)

Occasional dense collagen bands coursed through the tissue. A few foci of loose fibrous tissue containing engorged capillaries were noted. There was no evidence of glandular hyperplasia.

Diagnosis: Struma lymphomatosa.

The hospital postoperative course was uneventful and the patient was discharged from the hospital ten days later. At the time of her discharge the basal metabolism had not changed but there was a very noticeable improvement in her voice. Her postoperative course was observed and noted as follows:

	Weight	B.M.R.
July, 1941	118	−15 1 gr. thyroid extract three times a day
August, 1941	124	−20 1 gr. thyroid extract three times a day
October, 1941	128	−20 1 gr. thyroid extract three times a day
December, 1941	133	−24 1 gr. thyroid extract three times a day
February, 1942	139	−28 1 gr. thyroid three times a day
April, 1942	144	−29 1 gr. thyroid extract three times a day
June, 1942	145	−30 1 gr. thyroid extract three times a day
August, 1942	144	−18 1 gr. thryoid extract three times a day
October, 1942	136	−21 1 gr. thyroid extract three times a day
December, 1942	138	−17 1 gr. thyroid extract three times a day
February, 1943	134	−15 1 gr. thyroid extract three times a day
April, 1943	135	−16 1 gr. thyroid extract three times a day
June, 1943	134	−12 1 gr. thyroid extract three times a day
August, 1943	134	−13 1 gr. thyroid extract three times a day
October, 1943	130	−10 1 gr. thyroid extract twice a day
December, 1943	130	−10 1 gr. thyroid extract twice a day
March, 1944	130	−10 1 gr. thyroid extract twice a day
June, 1944	128	−12 1 gr. thyroid extract twice a day
September, 1944	129	−10 1 gr. thyroid extract twice a day
December, 1944	130	− 8 1 gr. thyroid extract twice a day
March, 1945	126	− 5 1 gr. thyroid extract daily
June, 1945	125	− 4 No thyroid extract
January, 1946	123	− 4 No thyroid medication

The first year following surgery was a very stormy one for the patient. She gained weight, felt "lazy," shunned her friends and wished to remain indoors. Her menstrual cycle ceased functioning for eight months but was balanced normally using A.P.L. substance with thyroid

extract. The patient had a complete personality change during this time and was very uncooperative. She was untidy in her dress and had little interest in her personal hygiene. She became a seriously disturbing influence upon other members of her family.

In the summer of 1942 her parents leased a cottage at a nearby lake and during this period the patient began to show improvement. From that time on progress was slow but steady. During the following year she worked part-time in a gift shop and in January, 1944 obtained a position as full-time saleslady. In the summer of 1945 this young lady was asymptomatic.

At this time her basal metabolism rate was −4; there were no symptoms or complaints and her weight was 125 pounds. This patient evidenced a rather severe hypothyroid reaction that was eventually controlled. I impressed upon her the importance of a check-up at least every year and sooner if she had any recurrence of her former complaints.

SUMMARY

1. Reidel's struma and Hashimoto's struma are different clinical and pathologic features of a chronic degenerative disease of the thyroid gland.

2. Conservative surgery is the procedure of choice in such cases.

3. A period of postoperative hypothyroidism that probably varies with the individual case ensues. Symptoms during this phase can be controlled medically. This period is undoubtedly a very important one and the patients should be followed carefully.

4. Following a period of four years, the two patients in this study reverted to a normal thyroid balance.

CONCLUSIONS

The one important fact that this study disclosed was the necessity of a careful clinical follow-up of the patient, using symptomatic therapy. Chronic thyroiditis is relatively rare, and one may psychologically help to control his patient with this fact, always insisting that eventually he will return to a normal condition. It is quite possible that there are patients that

return to a fair thyroid balance without medication. The hormone glandular chain is well known for its wide compensating abilities and probably plays a rôle in the eventual outcome of these patients.

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HEMORRHAGIC CYST OF THE SPLEEN
IN A CASE OF GAUCHER'S DISEASE*

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HEMORRHAGE resulting from insults to the spleen may present dramatic manifestations and at times pose interesting diagnostic problems. It is seen in several forms: (1) Immediate intraperitoneal hemorrhage following rupture of the splenic substance and its capsule; (2) delayed intraperitoneal hemorrhage due to the formation of a hematoma in or about the breach which subsequently ruptures; (3) no intraperitoneal hemorrhage, the hematoma remaining focal with resorption or hemorrhagic cyst formation. We have recently had the opportunity to study a case of Gaucher's disease in which a hemorrhagic cyst developed.

Hemorrhagic cysts of the spleen are rare. No previous case in Gaucher's disease has been described. The important feature in the case to be presented is not the medical curiosity but the manner in which it demonstrates the pathogenesis of splenic hemorrhage and the diagnostic problems accompanying such a lesion.

CASE REPORT

On February 8, 1942, a thirty-six year old white Jewish male was admitted to the hospital for the first time with the chief complaint of pain in the left upper quadrant, intermittent in character, moderate in severity and of one and one-half months' duration. In early January, 1942, during the course of a card game, the patient received a light blow to the abdomen. The trauma was minimal. Soon thereafter he experienced pain in the left upper quadrant and felt "dizzy and faint." The following day while at work he had a second "fainting spell." He continued to have periodic pain in the left upper quadrant and experienced many gastrointestinal symptoms such as eructation, nausea, vomiting, pain under the ribs and obstipation. He was treated by a local physician for a gastric disorder but without benefit.

Examination by another physician on January 27, 1942, revealed a cystic mass the size of an orange in the left upper quadrant extending to the umbilicus. The liver was felt 2 fingers below the costal margin. On January 31, 1942, the mass in the left upper quadrant appeared slightly larger, being felt 1 finger below the umbilicus. The blood count at this time was: hemoglobin, 94 per cent; erythroeytes, 4.89 million; leukocytes, 8,900, with polymorphonuclear leukocytes, 65 per cent; non-segmented forms, 2 per cent; lymphocytes, 25 per cent and monoeytes, 8 per cent. The platelet count was 310,000/cu. mm. Sternal marrow revealed a slight shift to·the left of the myeloid and erythroid elements. The total marrow count was 295,000/cu. mm. with 1,200 giant cells of the Gaueher type/cu. mm. The patient was admitted to the hospital to determine the nature of the mass.

Upon admission the patient stated that he had no episodes of weakness but had always been pale. There was no history of bone pain, bleeding tendeneies or dizziness prior to the traumatic incident. The rest of the history was non-contributory.

Physical examination revealed that the patient was a well nourished, well developed, pallid, white male who did not appear acutely ill. The temperature was 99°F. and the pulse 80. Examination of the head and neck revealed barely palpable lymph nodes. The heart and lungs were normal. The blood pressure was 140/90. A large mass was felt in the left upper quadrant. This extended to the midline and 1 finger below the umbilicus. The liver was palpable 1 finger below the costal margin.

During the next eighteen days the course of the patient was studied to determine the nature of the mass. On February 9, 1942, examination of the urine was negative. The complete blood count was as follows: hemoglobin,

100 per cent; erythrocytes, 5.4 million; leuko-
cytes, 9,000, with polymorphonuclear leuko-
eytes, 51 per cent; non-segmented forms,
5 per cent; lymphocytes, 34 per cent and mono-
cytes 10 per eent. The sedimentation rate was
5 mm. the first hour and 16 mm. the second
hour. On February 10, 1942, x-ray of the
abdomen revealed a mass density in the
region of the spleen. X-ray of the chest showed
no elevation of the left dome of the diaphragm.
Intravenous and retrograde pyelograms during
the following week demonstrated no morpho-
logic defect. Barium enema on February 14,
1942, revealed no intrinsic lesion of the colon
but the descending colon was pushed to the
right, showing evidence of extrinsic pressure.
The impression was "mass of the left side
causing extrinsic pressure." Repeated stool
examinations were negative for blood, ova or
parasites.

On February 23, 1942, a consultant stated
that the cystic mass to the left of the umbilicus,
apparently continuous with the spleen, "is
probably not the spleen and may be retro-
peritoneal and of a neoplastic nature." He
advised exploratory laparotomy. For this
reason the patient was transferred to the
surgical service of Dr. Charles Robbins. On
February 26, 1942, at operation a moderately
enlarged spleen was found adherent to the
diaphragm. Splenectomy was performed.

Gross pathologic report was as follows: The
specimen consisted of a spleen measuring 25 by
8 by 5 cm. (normal 12 by 7 by 4). The lower
two-thirds of the anterior portion of the spleen
was composed of an eneapsulated eystic mass
measuring approximately 16 by 8 by 5 em.
(Fig. 1.) This was clearly demareated from
the surrounding splenic tissue and was filled
with stringy, reddish-brown, clotted material
and hemorrhagie fluid. The outer surface of the
cyst was roughened; the inner surfaee was
smooth and grey-white in color. The eyst wall
measured 1 mm. in thickness. At the upper
pole there was another smaller cystic structure
similar to that previously described, measuring
5 by 3 by 2 cm. Elsewhere the serosal surfaee
of the spleen was smooth and glistening. The
cut surface of the spleen revealed a glistening,
light brown surface, studded with pinpoint
and linear translucent areas.

At histologic examination paraffin sections
were stained with hematoxylin and eosin,
Weigert's elastic and Van Gieson and by
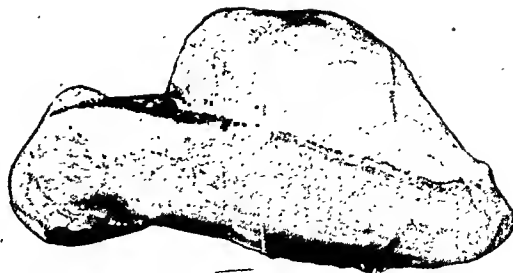
FIG. 1. Splenic cysts near the upper and lower poles.

Mallory's method for hemosiderin. That por-
tion of the spleen not in the vicinity of the
hematoma showed small, poorly demareated
Malpighian follicles. Diminution in the size
of the follicles was more apparent than real
and was due to the encroachment on and the
partial replacement of follicles by groups of
Gaucher cells. These cells were large, (30 to
50 micra) polyhedral, with relatively small
nuclei and at times horseshoe in shape. The
cytoplasm contained numerous fine fibrillae
with irregular light areas in the meshes.
(Fig. 2B.)

The large hematoma located beneath the
capsule for the most part was composed of
amorphous pink material, in some regions
granular and in others homogeneous. (Fig. 2A.)
There were several portions that may have
been of recent origin since erythrocytes in
these areas could still be identified although
they were pale-staining. Between the clot and
the splenic parenchyma there was a thick
layer of young connective tissue extending
into the hematoma. This formed the juxta
splenie wall of the cyst. The histiocytes in this
organizing tissue contained large amounts of
hemosiderin and the cytoplasm of the Gaucher
eells in the splenic tissue deep to the hematoma
also eontained small amounts of iron. Areas
of well preserved erythrocytes could be seen
at the periphery of the hematoma, in the
center of the degenerating clot and in the sub-
stance of the young connective tissue which
formed the deep wall of the eyst.

The splenic capsule formed the outer wall
of the eyst. The capsule appeared to be thick-
ened in some areas due to beginning organiza-
tion of the underlying clot. Other portions
showed a peritoneal reaction with fibroblasts
and infiltrating lymphocytes on the external
aspect of the capsule. The major portion of
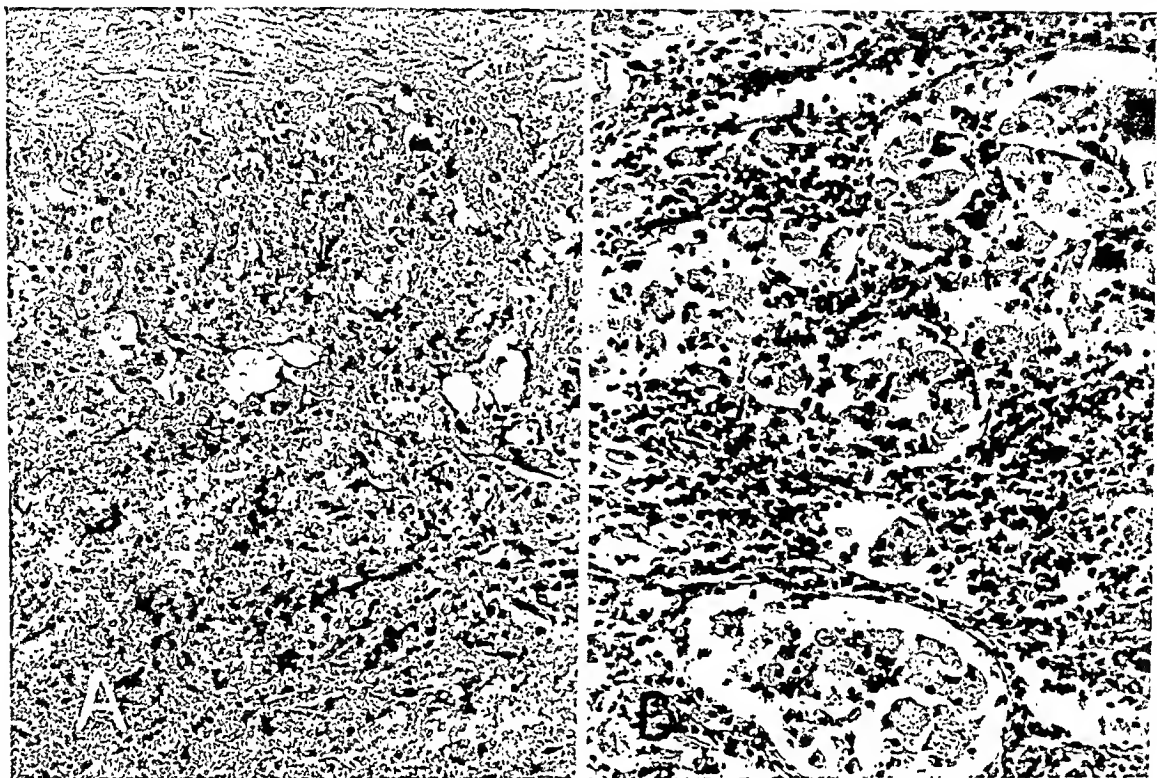
FIG. 2. A., subcapsular hemorrhage. Capsule shown at upper portion of illustration; Gaucher cells in area of organizing hemorrhage; B., shows Gaucher cells in spleen.

the splenic capsule, however, showed only beginning hyalinization of the collagen fibers.

The elastic stain demonstrated clearly that many trabeculae traversing the hematoma had been ruptured.

Diagnosis. Gaucher's disease of the spleen with formation of hemorrhagic cysts.

COMMENT

To develop logically the pathogenesis and symptomatology of hemorrhagic cyst of the spleen a brief review of splenic hemorrhage is in order.

The importance of immediate intraperitoneal hemorrhage following traumatic rupture of the splenic substance and its capsule is too well known to be discussed in this presentation. Spontaneous rupture of the diseased spleen with immediate intraperitoneal hemorrhage is also fairly well known. It has frequently been reported in malaria[21,32,28] and on occasion in leukemia,[17,29,31] infectious mononucleosis,[8,22] typhoid fever,[27] pneumonia, tuberculosis, hemophilia, polycythemia,[7] undulant fever,[36] endocarditis lenta,[12] portal vein thrombosis[1] and pregnancy.[33,35,37]

Several cases of so-called spontaneous rupture of the normal spleen have also been reported.[5,6,11,20,38,42] It may be that apparently insignificant trauma to the spleen whether it be external, mechanical[30] or internal (exaggerated physiologic response)[2] causes these spleens to rupture.

The syndrome of delayed intraperitoneal hemorrhage from a rupture of the spleen is less well known. It has frequently been referred to in the literature as "delayed splenic rupture."[16,19,26] The rupture of the spleen *per se* is immediate, whether it be a small parenchymal laceration or an extensive one involving the capsule. The delay is not in the rupture of the spleen but is, rather, the interval between the rupture of the spleen and the catastrophic intraperitoneal hemorrhage. For this reason the term "delayed intraperitoneal hemorrhage" is preferred to "delayed splenic rupture."

In the development of delayed intraperitoneal hemorrhage there are three phases: the original injury to the spleen, the insidious latent period and finally the fulminating intraperitoneal hemorrhage. The initial insult may vary from minor trauma to the left side to a severe injury. The latent period may range from hours to three months although statistics indicate that secondary massive intraperitoneal bleeding occurs most often between the third and seventh days.[13] The symptoms during this period may vary. Some patients have no complaints while others have mild abdominal discomfort or even persistent colicky pain. Localized tenderness and rigidity are uncommon. Rarely is there abdominal distention or slight temperature elevation.[25] On occasion there may be splinting of the left chest without pleural or pulmonary signs. X-ray may be negative or show cloudiness in the region of the spleen, elevation of the diaphragm or displacement of the stomach.[9] There may be an associated rib injury.[23,39]

Four original types of splenic injury have been described which result in secondary intraperitoneal hemorrhage, namely, parenchymal contusions, intrasplenic and subcapsular hematomas, initial parenchymal and capsular lacerations with perisplenic hematomas and finally pedicle tears.[41] The cause for the intervening latent period has been a subject of considerable discussion. Hageney[18] in a review of seventy cases considered the latent period to be due to intact splenic capsule in 75 per cent of the cases and the remainder due to blockage of the lacerated capsule by clots, omental adhesions or adhesions to other organs.

Onset of the fulminating secondary intraperitoneal hemorrhage is sudden and may be initiated by exaggerated physiologic response[2] causing an increase in intrasplenic pressure, or may be initiated by an increase in intra-abdominal pressure produced by exertion[30] or by straining at stool. The symptoms and signs in the third phase of the syndrome are those of severe intraperitoneal bleeding. Dullness in the left flank (Ballence's sign) or pain in the left shoulder (Kehr's sign) might give an important lead as to the source of the bleeding.

The category of "combined" intraperitoneal hemorrhage from the spleen includes those patients with initial intraperitoneal hemorrhage which becomes walled off and localized only later to result in massive intraperitoneal bleeding. Here the clinical picture is similar to that of delayed intraperitoneal hemorrhage, but from a viewpoint of pathogenesis there must be a separate classification.

Those cases of intrasplenic or subcapsular bleeding which do not result in secondary intraperitoneal hemorrhage may be absorbed, may organize or may result in the formation of hemorrhagic cysts. Fowler[14] classifies these as pseudocysts.

Many ideas have been proposed in the attempt to explain the production of hemorrhagic cysts. It is known that antecedent disease, usually with splenic enlargement, is the most important underlying factor since such spleens are more exposed to trauma and probably more easily traumatized. Enlarged spleens, furthermore, have a greater tendency toward formation of adhesions with other organs. This reduces mobility and permits a greater traumatic effect. Statistics have shown that trauma has been established as the etiologic agent in approximately 30 per cent of all cases of large hemorrhagic cysts.[10] In the case presented the spleen was enlarged, adherent to the diaphragm and subjected to trauma. The exact rôle that Gaucher's disease played in the production of the hematoma, other than splenomegaly, is difficult to evaluate. The fact that tendency to hemorrhage may occur in Gaucher's disease should be considered.[40]

Other less common causes of hemorrhagic cyst formation are inflammatory disease, vascular lesions such as thrombosis or embolism of the splenic vessels or

hemorrhage into a degenerated metastatic neoplasm.

If the cyst is small, there may be no symptoms. If it reaches a large size, as it did in this case, there may be vague digestive disturbances such as nausea, anorexia, vomiting or obstipation from the pressure of the mass. There may be pain in the form of a dragging sensation localized to the left upper quadrant. Physical examination may reveal a large mass in the left upper quadrant extending to the midline or possibly down to the umbilicus. It may be fluctuant if the contents are liquified. X-ray may reveal a high diaphragm with impaired motion, the stomach pushed to the right and the colon displaced downward and to the right. If there is calcification, this, too, is recognizable. In general the diagnosis is not too difficult if the condition is borne in mind. It must be differentiated from cysts of the pancreas, omentum and mesentery[24] as well as other retroperitoneal tumors.

The pathogenesis of hemorrhagic cysts following trauma is interesting. In 35 per cent of the cases hemorrhage occurs centrally in the parenchyma of the spleen and in 65 per cent of the cases[14] it occurs peripherally in the subcapsular region. Hemorrhage continues until there is sufficient increase in tension within the hematoma to compress the bleeding site. When organization with the subsequent formation of a fibrous wall occurs, an encapsulated hemorrhagic cystic structure results. Later, with the absorption of blood pigment, the hemorrhagic cyst may be converted into one of the serous type as occurs in 30 per cent of the cases. Calcification of the cyst wall may occur. Fowler points out that approximately 9 per cent of all such cysts become calcified.[14]

In many respects the early stages in development of a hemorrhagic cyst and of delayed intraperitoneal hemorrhage from the spleen are similar. In both, trauma is an important factor. Following this, there is a subcapsular hematoma in a large proportion of both conditions. In delayed hemorrhage before there is an opportunity for organization and fibrous encapsulation some event such as increased intrasplenic pressure due to exaggerated physiologic response[2] or increased intra-abdominal pressure from straining at stool, etc., precipitates the ominous intraperitoneal bleeding. In cyst formation the organization processes are sufficient to prevent catastrophe.

SUMMARY

1. A case of hemorrhagic cyst formation in the spleen in a patient with Gaucher's disease is presented.

2. The relationship between hemorrhagic cyst formation and ruptured spleen with delayed intraperitoneal hemorrhage is emphasized.

3. The subject of splenic hemorrhage is briefly reviewed.

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TREATMENT OF WOUNDS OF THE POPLITEAL ARTERY

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USE of Vitallium tubes in anastomosis of severed arteries, as contributed by Arthur Blakemore of Columbia University, has meant the saving of many extremities rendered ischemic after injury to the major artery of the limb. The technic requires that one have available a series of small Vitallium tubes and be practiced in their use in order to expect success in bridging the defect produced in the injured artery.

During the recent war in the Mediterranean theater a number of injuries to the popliteal artery were treated by the use of Vitallium tubes. Although it is probable that the associated injury to soft parts greatly affected the success of the treatment, no significant improvement in the results occurred in the patients in whom Vitallium tubes were used compared with those treated by other methods.

Suffice to say, a wound of the popliteal artery with extensive hemorrhage is a surgical emergency that should be attended at once. Every surgeon may at some time be faced with such a case and few will have the Blakemore tubes in assorted sizes at his disposal. In the average instance the surgeon will be forced to ligate the artery to control hemorrhage.

The appearance of ischemic gangrene of the distal portion of the lower extremity as a sequel to ligation of the popliteal artery, especially when the ligation is incident to wounding of the artery by bullet or similar agent, has become so frequent that an exceptional case warrants reeitation of its management in detail. It is possible that others confronted by similar cases and employing the same measures may establish the treatment.

CASE REPORT

An American soldier, aged twenty-three, was accidentally wounded by a 7.2 mm. Beretta bullet in the medial aspect of the upper portion of the middle third of the left thigh in the region of Hunter's canal, the bullet apparently ranging downward. Within one hour the patient arrived at a station hospital where he was immediately examined. The left leg was held in semi-flexion at the knee and the foot was noted to be pale and cadaveric in appearance. The lower third of the thigh was swollen and tense with an almost board-like resistance to pressure. There was practically no external bleeding from the wound. No pulse could be felt in either the anterior or posterior tibial arteries and the veins at the ankle were not perceptable. Palpation of the leg caused extreme pain to the patient, especially when the calf muscles were touched. While the operating room was prepared, x-rays of the leg and thigh were made, using pieces of wire as markers to plot the approximate course of the bullet. It was found to have lodged between the tibia and fibula in the upper third of the leg. Under spinal novocain anesthesia with a tourniquet in place the medial aspect of the thigh was opened over Hunter's canal and the incision extended to the posterior aspect of the knee to expose the popliteal space. A huge hematoma was evacuated from the popliteal space and the torn popliteal artery visualized. The artery was found to have been lacerated longitudinally but was still held in continuity by a thin band of contused anterior portion of the vessel wall. An attempt was made to close the wound in the vessel by multiple sutures while flexing the knee; however, the artery was so badly contused that the effort was fruitless. The artery was then exposed proximally to the first large branch of the popliteal artery, and a ligature of No. 1 chromic catgut was placed just distal to this vessel. The tourniquet was released and the wound irrigated with saline to remove clots of blood while bleeding points were located and ligated. After fifteen minutes no pulsations could be detected in the distal ligated portion of the popliteal artery. The popliteal vein which had not been injured was observed to be collapsed. This vein was then doubly ligated with No. 1 chromic catgut and divided. The cut edges
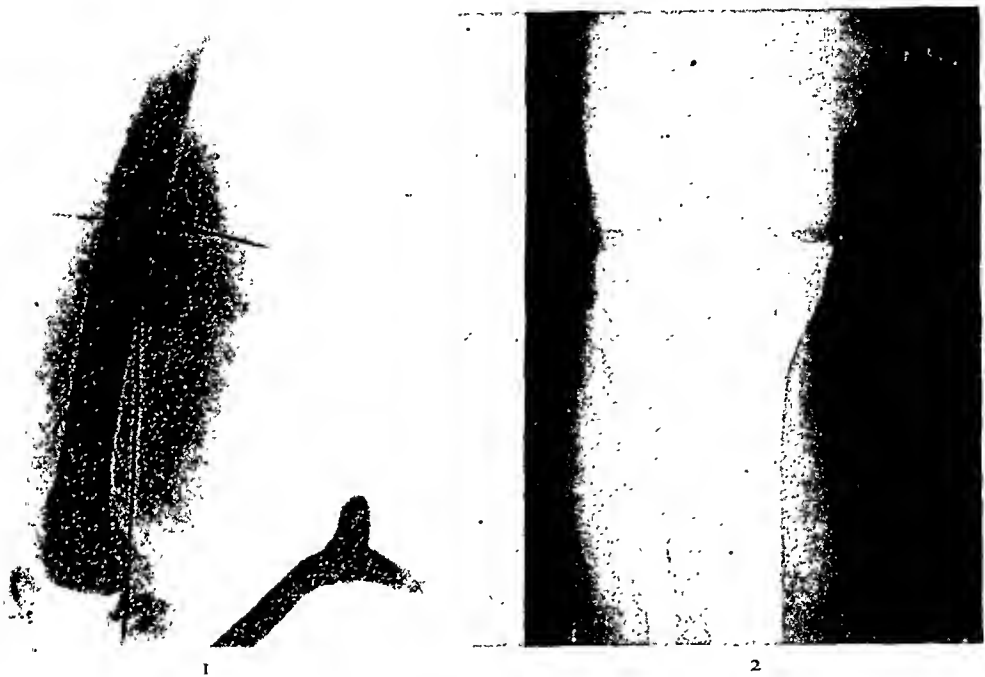
FIG. 1. Lateral view of thigh with crossed wires at the point of entrance of the missile and the approximate course of the bullet through the thigh which was verified at operation.

FIG. 2. Location of bullet in upper calf region between tibia and fibula after having ricocheted from the condyle of the femur.

of the skin and muscle at the site of the wound were noted to bleed freely by this time. Sulfanilamide, 5 Gm., was dusted into the wound and closure was performed by the insertion of interrupted "O" chromic catgut sutures in the fascia. The skin closure was accomplished with interrupted fine silk sutures. A light supporting splint with a loose dressing was applied and the patient was put to bed, maintaining the leg and foot on a horizontal plane with his body. A cradle was placed over the leg to support the bed covers. The patient suffered some pain during the first three days but the foot was observed to be warm and pink in color within the first six hours following operation. Passive motion of the foot was insisted upon, beginning the third postoperative day. The incision in the thigh healed without infection. Trendelenburg exercises were begun at the end of one week at which time the patient was allowed up for short intervals on crutches. After sixty days the bullet was removed from between the tibia and fibula because of a mild persistent swelling in the calf muscles and pain experienced at that site upon weight bearing. Healing was uneventful. Physiotherapy and leg and ankle exercises of increasing force, were given at this time followed by rapid return of strength in the leg. Seventy-two days after injury the patient

returned to duty. At that time no abnormality of the leg and foot could be detected except the absence of both the anterior and posterior tibial pulsations at the ankle; however, no pain was experienced by the patient even after vigorous walking or climbing stairs. Following his return to duty, periodic observations of this patient were made. After four months from the date of injury the pulse was found to be easily palpable in both the anterior and posterior tibial arteries of the wounded leg. Comparative measurement of the patient's legs at that time showed the injured leg to be 1 inch less in circumference about the thigh at the site of the injury and $\frac{1}{2}$ inch less in circumference at the largest portion of the calf. Subjectively, the patient complained only of slight heaviness of the left leg and some swelling of the left ankle after long walking or standing. (Figs. 1 and 2.)

COMMENT

It is obvious that early operation is indicated in the instance of extensive laceration of the popliteal artery, not only to control loss of blood but to reduce the mounting tamponade to collateral circulation. In the case just described the tissues in the popliteal region were under

extreme tension. Sehrt and Heidreich, corroborated by Brooks, cited by Holman in Christopher's "Textbook of Surgery" have statistically and experimentally established that there is a lessened incidence of gangrene following ligation of a large artery and its accompanying vein as compared to ligation of the artery alone. Simultaneous ligation of the artery and vein aids in maintaining a proper balance between the arterial and venous systems of the extremity distal to the point of ligation. Pemberton, also cited by Holman, observed the absence of pulsation in the distal segment of a ligated artery as an evidence of inadequate collateral circulation and employed it as indication for ligation of the accompanying vein to increase resistance to the return flow of blood to the heart as an aid in establishing a more efficient collateral circulation. It was not necessary to block the lumbar sympathetics in the case herein presented because of early appearance of warmth and normal color following operation. Had there been later evidence of vasospasm, lumbar sympathetic block would have been employed during convalescence. One detail which we believe to be of important

significance in the successful establishment of collateral circulation in this case was the selection of the site for ligation of the popliteal artery immediately distal to a large branch above and immediately proximal to a similar branch below the level of injury. Although thrombosis of a ligated artery progresses backward from the point of ligation to a collateral branch in most instances, a strong pulse may be observed in the proximal stump of a ligated artery for days following ligation. It appears that by ligating an artery immediately adjacent to a collateral branch, the full force of blood pressure will be translated to the collateral vessels rather than be dissipated in the blind pocket distal to the collateral branches.

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DOUBLE GALLBLADDER

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THAT a double gallbladder is a rare congenital anomaly has been proven by many investigators. Wilson[1] reviewed the literature from 1674 through 1939. Gross,[2] Stolkind[3] and more recently Guyton[4] presented excellent reviews. Guyton[4] revealed only 40 proven cases of this anomaly. To this he added his own, the forty-first. The incidence of this anomaly in man has been quoted as one case in every four to five thousand persons. Boyden[5] found, in a collective study, two cases in 9,221 cadavers from eleven anatomic laboratories.

Boyden's[5] classification of double gallbladders has been accepted by both American and European investigators. It simply divides this anomaly into two groups: vesica diversa, bilobed or cleft gallbladder which has a septum dividing the organ into two chambers emptying into a common cystic duct. The second group, vesica duplex, has two gallbladders with two cystic ducts. This second group is further divided into the "Y" type with two cystic ducts draining into a common cystic duct, and the ductular type with two cystic ducts draining separately.

Discrepancies in the literature do exist in classification of the specimens. For example, Gross[2] in 1936 reviewed six cases of bilobed gallbladder. Stolkind[3] in 1939 reported seven cases of bilobed gallbladder and added the eighth to the literature. Guyton,[5] in the most recent review, reported only five cases of bilobed gallbladder and added his own to the literature. Hilt's[6] case was presented in 1937 after Gross's[2] review. However, the only cases occurring consistently in the reviews of the previously named authors are those of Meyer,[7] Rycroft[8] and one of Phillips.[9]

It is not the purpose of this paper to classify or reclassify the specimens of this anomaly occurring in the literature. We are in agreement with Guyton[4] in his classification in which he states eleven cases were insufficiently described. We believe the case herein presented falls into the group of vesica duplex of the ductular type. Guyton[4] reviewed sixteen of this type of anomaly.[1,2,10—23]

CASE REPORT

Mrs. J. Z., A. H. A2037, a sixty-three year old white woman, was admitted on July 19, 1946, for surgical management of a progressive obstructing lesion of the sigmoid colon. The chief complaint was pain in the abdomen of a cramping character which was becoming progressively worse. She had alternate bouts of constipation and diarrhea.

The present illness had its onset three weeks prior to admission. She had lost approximately 20 pounds in the past three months which she attributed to loss of appetite. Vomiting occurred on only one occasion. The changes of bowel habit was first noted three years prior to admission.

The past history revealed three previous operations, the first twenty-seven years prior to admission at which time the right tube, ovary and appendix had been removed; at the second, fifteen years later, a thyroidectomy was accomplished; three years prior to admission at the age of sixty, she was hospitalized and treated with radium for "bleeding from the uterus."

Physical examination revealed a well developed and fairly well nourished woman in no apparent distress. Temperature on admission was 99°F. rectally, pulse 76, respiration 22, blood pressure 110/60, weight 102 pounds and height 5 feet 2½ inches. The abdomen was flaccid with some tenderness in the left lower quadrant and lower midline upon deep palpation. There were no palpable masses. Rectal examination was negative. The remainder of the examination was non-contributory. X-ray examination had been taken elsewhere and revealed an obstructing lesion of the sigmoid
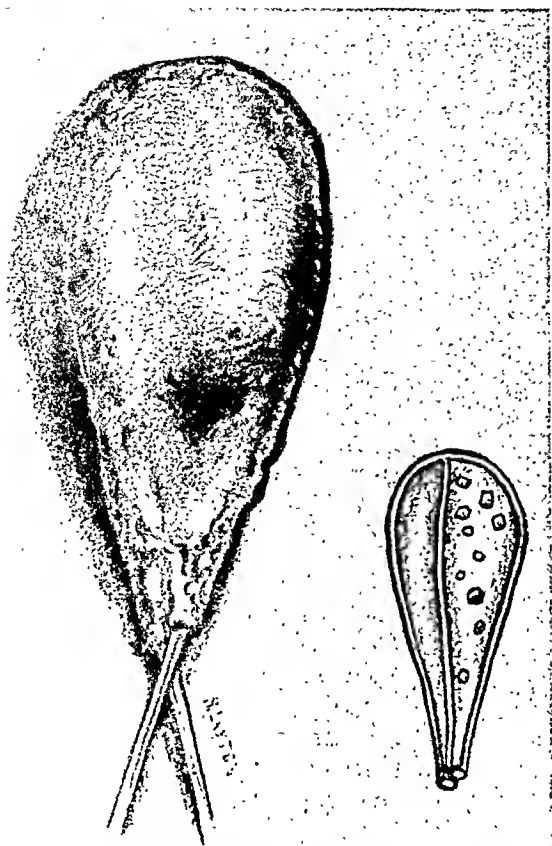
FIG. 1. Artist's drawing of double gallbladder. Note stones in the larger gallbladder which also contained darker colored bile.

colon. The red blood cell count 3,200,000, white blood cells 4,100, hemoglobin 10.8 Gm. and urine examination was negative.

On July 22, 1946, through a low transverse incision, a partial obstruction of the sigmoid was found, caused by dense adhesion between the omentum, left round ligament, ovary and tube. The adhesions were freed. Upon exploration the gallbladder was found to be markedly distended and enlarged. The wound was closed and the abdomen prepared and redraped. Through a right paracostal incision the gallbladder and bile ducts were exposed. The gallbladder and common bile duct were found to be markedly distended. To facilitate removal of the gallbladder which was found in its normal liver fossa it was aspirated and thick, dark green bile was removed. The portion of the gallbladder lying next to the liver collapsed. The needle was withdrawn and reinserted and a lighter green bile was removed. This collapsed the gallbladder. What appeared to be two cystic ducts were clamped, cut and doubly ligated. A cholecystectomy was accomplished.

The common bile duct was then explored and several small stones were removed. A T tube was inserted for drainage.

The postoperative course was uneventful and without complications. The patient was up on the second postoperative day, the T tube was removed on the twelfth and the patient was discharged from the hospital on the nineteenth postoperative day.

The pathologic specimen, A. H. 15109, (Fig. 1) consists of a gallbladder 8.5 cm. long and 4 cm. across. It is made up of two separate cavities, each is lined by a mucosa. There is a complete septum between the cavities. There are two cystic ducts. These cavities are unequal in size. The larger is twice the diameter of the smaller. The large cavity is filled with a dark, thick bile and many stones with sharp corners and edges. These stones vary from 2 to 3.5 mm. in size. The smaller cavity contains a thick green bile.

Histologic Description. A section of each of the component parts shows chronic inflammation with fibrous thickening. One of the sections contains lipoid-filled mononuclear cells. The pathologic diagnosis is chronic cholecystitis with cholelithiasis and cholesterolosis.

CONCLUSION

1. The congenital anomaly of reduplication of the gallbladder is rare.

2. A case of vesica duplex of the ductular type is presented.

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According to Pulaski et al., streptomycin is not a panacea but does have distinct value in numerous cases, especially in instances of spreading peritonitis. They studied its effects alone or in conjunction with large doses of penicillin and occasionally also with the sulfa drugs in sixty-three patients, and they believe that streptomycin does *not* seem to have distinct value in localized peritoneal suppuration. It has proven, however, to be a valuable adjunct in most all cases of spreading peritonitis as well as in other types of surgical infection. Personally, this writer's best results in peritonitis have occurred when he combined streptomycin therapy with *large* doses of penicillin. (*Richard A. Leonardo, M.D.*)

BILATERAL CAROTID BODY TUMOR

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THE carotid body was first mentioned in the literature by Von Haller (1743) and was described by Neuber (1783). An excellent detailed microscopic description was recorded by Luschka in 1862. The first carotid body tumor was removed by Riegner in 1880 and described by Marchand in 1891. Scudder (1903) is given credit for the report of the first verified case of carotid body tumor in America. At present about 291 carotid body tumors have been described in the literature. Few surgeons have operated upon more than two patients.

Bilateral carotid body tumors are extremely rare. There are but five such cases recorded in the literature. Lund (1917) reported the first case of carotid body tumor occurring bilaterally. He removed a tumor from the right side of the neck of a patient from whom a left carotid tumor had been removed twenty-nine years previously. Rankin and Wellbrock (1931) reported a case in which bilateral tumors appeared simultaneously. In 1932 De-Tarnowsky reported a case in which a tumor of the opposite side had been removed in 1904. Chase (1933) reported the occurrence of bilateral tumors in a patient whose sister had had a carotid body tumor removed. The occurrence of bilateral tumors was reported in 1939 by McNealy and Hedin; in this case the patient's brother presumably had had a carotid body tumor.

The occurrence of this tumor bilaterally is so rare that the case herein submitted is of sufficient interest to merit its report.

CASE REPORT

A white salesman, forty-eight years of age, entered this tumor service in April, 1945, complaining of progressive swelling of the glands in his neck.

The family history revealed that the patient's mother was living and well; his father was dead, the cause of death being unknown. One brother was living and well. There was no history of tuberculosis or any glandular enlargement of the neck. The past history contributed that the patient had measles and mumps in childhood. He considered his health excellent at the time of enlistment in the Army. While in the service, he contracted influenza. He had been operated upon in 1922 and a submucous resection had been done; in 1924 he had a sinus operation; in 1932 twelve teeth were extracted and in 1934 a tonsillectomy was performed. The patient denied any history of venereal disease. For the past eleven years he had not had a day of sickness or been confined to bed and had worked steadily as a salesman. The onset of symptoms began in September, 1932 after an extraction of twelve teeth. He noted a small lump beneath the angle of the jaw on the left that increased in size for a year and then seemed to remain unchanged. In March, 1943 he noted a swelling in the right side of his neck which gradually enlarged. One year prior to admission to the hospital both swellings began to increase in size so rapidly he sought medical attention.

The patient had maintained his weight of 155 pounds for the past fifteen years. His appetite had not changed and there was no history of dysphagia, nausea or vomiting. Upon questioning there was no history of dyspnea on exertion, cyanosis or palpitation. The pressure symptoms such as headache, vertigo, cough, or dysphonia were not present.

Physical examination showed that the patient was of medium height, a well nourished adult white male, well orientated and cooperative. He did not appear acutely or chronically ill; he was freely ambulant and in no pain. The patient's height was 69 inches; his weight

158 pounds. The eyes reacted to light and accommodation. The mouth revealed moderately advanced pyorrhea of the remaining teeth on the right. The nasopharynx, pharynx, buccal mucosa and tongue revealed no gross evidence of pathologic disturbances. A 6 mm. squamous cell carcinoma was seen on the lower left lip which, according to the patient, had developed within the last few weeks and obviously had no connection with bilateral masses of the neck which were of many years' duration. The patient heard a whispered voice at 15 feet with each ear and a conversational voice at 25 feet equally well.

Examination of the neck revealed bilateral masses. The mass on the right measured 8 cm. in length and 4 cm. in width. It extended from the mastoid process and from the angle of jaw and was beneath the sternocleidomastoid muscle extending downward to the mid-portion of that muscle. This mass was movable from side to side but not up and down. It was firm, smooth and non-tender. Transmitted pulse of the great vessels could not be palpated. The tumor on the left side measured 6 cm. in length, 4 cm. in width. It, too, was firm, smooth, non-tender and was more fixed to the deeper structures than its fellow. The location was approximately the same. When pressure was applied over both masses, there was only slight slowing of the heart rate. This was confirmed later by electrocardiogram tracings. No thrill or bruit was present over either mass. The blood pressure was 90/60. The heart and lungs were normal. Abdominal and neurologic examinations were negative. Examinations of the blood and urine showed nothing of interest. The electrocardiogram was normal.

Preoperatively, the patient had thirteen teeth extracted and deep x-ray therapy was used on the lesion of the lower lip. This lesion showed regression in two weeks.

The working diagnosis at the time of surgery was bilateral tumor of the neck, type undetermined. The possibility of bilateral carotid body tumor was considered.

At operation the mass on the right was approached first. Novocain, 1 per cent, was used for local infiltration and novocain, 2 per cent, was used for cervical block. An incision paralleling the sternocleidomastoid muscle was made. This muscle was retracted lateralward for some distance. The carotid sheath was entered at the level of the omohyoid muscle

and the common carotid was freed to a point 2 cm. below its bifurcation. Here a tumor mass completely surrounded the common carotid. Pushing the internal jugular vein laterally, the wall of the vessel was found to be incorporated in the mass. Careful dissection from below upward was attempted but profuse bleeding was encountered. An attempt was made both laterally and medially, but these approaches were blocked by profuse bleeding. The tumor was inseparable from the arteries for two reasons: first, because of the dense adherence of its capsule to the adventitia of the vessels and, second, because of the network of the thin walled vessels that covered its surface. Returning to the carotid sheath, the vagus nerve was identified. It, too, was incorporated in the mass. A biopsy was taken and with great difficulty bleeding was controlled with suture ligatures.

At this point an evaluation of the situation led to the conclusion that the mass could be removed only by ligation of the common carotid and also the possibility that the vagus nerve would have to be sectioned. Knowing that this mass was bilateral and an unknown situation concerning blood supply existed on the opposite side, the wound was closed. Consideration was given to the possibility that the opposite side might be operable without sacrificing the blood supply. In that event ligation of the common carotid and removal of the mass on the right side could be attempted. The seriousness of this procedure, in view of the hazards which accompany ligation of the common carotid, was appreciated.

The pathologic report of the biopsy taken was carotid body tumor.

The opposite side of the neck was explored eight days later, using the same anesthesia and incision. The mass was freed from the medial border of the sternocleidomastoid muscle. It grossly resembled its fellow. The dissection was carried out from below upward and laterally. Much bleeding was encountered, but the tumor mass was freed from the common carotid and the external carotid arteries. The internal jugular vein was sacrificed. At this point the internal carotid and the vagus could not be dissected free. These structures were surrounded by the tumor and were densely adherent to it. Manipulation or traction of the mass caused immediate emesis, drop in blood pressure, slowing of the pulse and profuse sweating; therefore, only a biopsy was taken

FIG. 1. Microsection of biopsy specimen removed. Note nests of polyhedral and elongate cells surrounded by vascular spaces lined with endothelial cells giving an alveolar-like appearance. 150 ×.

FIG. 2. Postoperative picture of patient shows the bilateral carotid body tumor which proved inoperable.

and the tumor was considered to be inoperable. (Figs. 1 and 2.)

Pathologically, the microscopic studies on both specimens removed were identical. Microsection disclosed a new growth made up of nests of polyhedral and elongate cells surrounded by vascular spaces lined with quite definite endothelial cells, giving the growth an alveolar-like appearance. The cells as noted were polyhedral to slightly elongate and had oval, moderately hyperchromatic, quite uniform nuclei, with practically no nucleolus. The vascular channels surrounding these polyhedral nests of cells were lined with endothelial cells. There were no mitotic figures. The cells were quite uniform and there was very little evidence of rapid growth. The diagnosis, based on microscopic study, was bilateral carotid body tumor.

Postoperatively, the patient continued to show vagal irritability and was unable to retain food for ten days. The vomiting spells gradually subsided and the wound healed without complications. Upon completion of a course of deep irradiation therapy consisting of 2,100 roentgens to each tumor mass, the patient was discharged from the hospital.

Sixteen months have elapsed since his release from the hospital. His follow-up questionnaire states that the tumors are slightly larger, cause no pressure symptoms and that he is able to work a full day.

COMMENTS

The etiology of these tumors, as of other tumors, is unknown. Both sexes are equally affected. Negroes are susceptible as well as white people. Patients vary in age from seven to seventy-three years, but 90 per cent of the cases reported have been of patients between the ages of thirty and sixty years. Of the five bilateral occurrences the familial incidence is mentioned in one.

It has been noted that the incidence of intra-oral infection preceding these tumors is remarkable. In the case presented the patient had an extraction of his teeth, tonsillitis and sinusitis. It must be mentioned again that the early carcinoma of the lower lip was of recent origin, developing a few weeks prior to admission and that from the long-standing history of the bilateral tumors they cannot be considered a part of the same pathologic process. Microscopic studies of the specimens removed confirms this contention.

It is usually considered that about 80 per cent of carotid body tumors are benign.

In this case the tumors that were present were benign histologically but malignant by position, in that circulatory embarrassment was to be expected.

In about 50 per cent of the reported cases it has been necessary to sacrifice the common carotid. This procedure carries about a 25 to 35 per cent mortality and of those that survive the operation, about 50 to 55 per cent suffer permanent brain damage. With ligation of the common carotid, the mortality rises with the age of the patient. The close proximity of this tumor mass to the vagus, hypoglossal, recurrent laryngeal, phrenic and glossopharyngeal nerves renders these structures liable to damage with various permanent defects.

SUMMARY

A case of bilateral carotid body tumor has been presented. It is interesting from a clinical viewpoint and offers a difficult surgical problem.

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FIFTEEN authentic cases of cancer of the parathyroid have been reported, only half of them being endocrinologically active. They ranged in size from 3 to 10 cm. when first seen but many become larger later. Benign tumors occur about 100 times more often than malignant tumors in the parathyroids, according to the studies of E. H. Norris. (*Richard A. Leonardo, M.D.*)

CHRONIC ABSCESSES SECONDARY TO CHOLELITHIASIS AND PERFORATION OF THE GALLBLADDER*

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FISTULOUS communications between the biliary passages and other viscera are frequently observed both at operation and at autopsy. In view of the frequency of gallstones and cholecystitis the occurrence of a fistula is an unusual complication. A discussion of the frequency and types of fistulae associated with the gallbladder has been given by Robson,[1] Judd and Burden[2] and Taylor.[3] In all probability perforation with the formation of a fistula does not take place in inflammatory disease of the gallbladder in the absence of complicating lithiasis.[2]

In reviewing the literature on fistulae associated with cholecystitis it appears that erosion of the wall of the gallbladder followed by a chronic abscess is infrequent. Usually such an abscess erodes the wall of an adjacent viscus and then produces a true fistula. The dense fibrous adhesions so often found around the gallbladder in cases of cholelithasis may in some cases develop secondary to erosion of the wall as the result of stones.

Sometimes a small, narrow sinus may connect the area of erosion in the wall of the gallbladder with a large subphrenic abscess. The etiology of such an abscess might very easily be overlooked at operation if the gallbladder is not carefully examined. The type of the contents in such an abscess cavity, of course, would be significant in determining its etiology. Those accompanying an acute empyema of the gallbladder would be that of a pyogenic process; however, if the lesion resulted from the action of bile, the contents might be brownish-black in color with few if any bacteria. Masses of bile pigment may be demonstrated in the wall. Mononuclear cells filled with fat vacuoles "foam cells" may be conspicuous in the inflammatory reaction. Hemorrhage may occur as the result of erosion of blood vessels by the bile.

Recently we have studied at autopsy two cases in which the wall of the gallbladder was eroded, apparently as the result of the presence of biliary stones. Each individual was obese, the one a male fifty-eight years of age and the other a female seventy years of age. In the former, death resulted primarily from the abscess while in the latter the clinical manifestation suggested biliary involvement; however, death resulted from bronchopneumonia. These two cases seem to be of sufficient interest from both a clinical and a pathologic standpoint to warrant publication.

CASE REPORTS

CASE I. The patient was an obese, white male, fifty-eight years of age, who entered the hospital with the complaint of pain under the right shoulder and along the right side of the chest for twelve days' duration. These pains were sharp in character and occurred at intervals of five to ten minutes. Subsequently, they radiated to the right upper abdomen. The abdominal pains were sharp and colic-like. He was nauseated and had vomited. There was diarrhea with five to six stools daily; this was followed by constipation. The pains were present daily during the illness. An attack similar to the present one occurred eight weeks previously and subsided under forty-eight hours. He was able to work as a guard during the interval.

Upon admission the patient was obviously in pain. There was generalized abdominal

tenderness with marked tenderness in the right upper quadrant along the costal margin. This tenderness extended downward to the lower right quadrant and across to the mid-epigastric region. A few fine râles were present at the base of both lungs. The temperature was 101.4°F.; pulses were 104 and the respiratory rate was 34 per minute. The systolic pressure was 135 mm. Hg and a diastolic pressure was 65 mm. Hg.

The white blood cell count was 14,000 two days following admission and subsequently decreased to 7,900 on the day of death. There was a moderate degree of anemia. A roentgenogram of the chest showed bilateral atelectasis in both bases. The diaphragm was elevated on both sides and an air-fluid level was thought to be present under the right arch. Fluoroscopic examination and films of the stomach and duodenum, however, did not reveal any organic disease.

The patient remained in the hospital for twelve days during which time the temperature varied between 101 and 102°F. On the last day of life the temperature reached 104.8°F. Although he appeared to improve during the first few days of hospitalization, he soon began to show signs of circulatory failure which persisted until death.

The autopsy was performed three hours after death. Only the pertinent findings are reported. The lower extremities were edematous; the abdomen was markedly distended. The gastro-intestinal tract was dilated with gas and the omentum was firmly adhered to the anterior abdominal wall. A cavity was present in the area of the left colic gutter that contained approximately 800 cc. of thick, brown fluid in which there were blood clots. This cavity extended upward between the spleen and the left lobe of the liver and then turned medially. Here it lay between the diaphragm and the left lobe of the liver. The stomach was anterior and inferior to the abscess cavity. This cavity extended retroperitoneally across to the midline of the abdomen and turned downward toward the right colic gutter. The greatest amount of the contents was present in the area of the left colic gutter. The wall of the cavity was moderately thick and the inner surface was covered with a thin, brownish exudate. A small sinus 3 to 4 mm. in diameter extended directly downward from the gallbladder to join this large cavity. The wall of this sinus was

similar to that of the cavity; it was bile stained. A small perforation was present in the wall of the gallbladder. The wall was thickened and was infiltrated with chronic inflammatory cells. Several stones were present in the lumen. Only a few gram-negative bacteria were present in a smear made from the contents of the large cavity.

Comment. An erosion occurred in the wall of the gallbladder secondary to the pressure produced by the stones. A small amount of bile escaped from the gall-bladder and formed a short sinus which subsequently formed the retroperitoneal abscess which extended toward the left side of the abdomen. A large subphrenic abscess developed which subsequently dissected down the left colic gutter. The contents of the cavity were bile stained. It did not resemble a pyogenic abscess like those that result from a perforation in the gastrointestinal tract. Furthermore, no lesion was demonstrated in the intestinal tract. Apparently one or more blood vessels in this cavity eroded since blood clots were found within the contents.

There was little in the past history to suggest biliary disease. There was no history of jaundice. Although the roentgenographic examination of the abdomen suggested a perforation in the gastrointestinal tract, no such lesion was found at autopsy.

CASE II. The patient was an obese white female, seventy years of age, who was in a semicomatose and completely disoriented state. The history was obtained from her daughter. The patient's health was "fairly good" until seven weeks previously when she suddenly developed severe pain in the epigastrium and right upper quadrant which lasted for only a few hours. This was accompanied by vomiting. Relief followed a dose of castor oil and several enemas. Similar attacks of abdominal pain occurred and three weeks previous to hospitalization the patient was weak and remained in bed. The pain persisted in the right upper quadrant and she became increasingly drowsy, uncooperative and irrational. Cathartics were given frequently during this time. The patient was thought to have had fever intermittently during the previous seven weeks.

An operation was performed on the gallbladder twenty years ago, the type of which was unknown. The daughter stated that her mother had similar attacks of pain and vomiting during the past five years. These subsided, however, following bowel movements. A chronic non-productive cough had been present for several years.

The patient appeared to be both chronically and acutely ill and was semicomatose. She was incontinent; the skin was dry. Pressure on the old scar in the upper right quadrant and deep pressure over the entire abdomen seemed to cause pain. The abdominal viscera could not be palpated; no other significant clinical findings were elicited. The neurologic examination was non-contributory. The temperature was 100°F., pulse 80 and the systolic pressure was 128 mm. Hg and the diastolic was 88 mm. Hg.

The white blood cell count was 12,900 with a normal differential. The hemoglobin was 15 Gm. The icteric index was 6 and the non-protein nitrogen was 40 mg. per cent. The total serum protein was 6.92 Gm. per cent, albumin 3.78 Gm. per cent and globulin 3.14 Gm. per cent. The albumin-globulin ratio was 1.20.

During hospitalization she remained disoriented and slept most of the time. The spinal fluid contained 49.5 mg. per cent of protein, 71.3 mg. per cent of sugar and the chlorides were 700 mg. per cent. The spinal Wassermann reaction was negative and a culture of this fluid was sterile. Three days before death a few râles were found in the base of the left lung posteriorly. Two days later moist râles were present in both lungs. The temperature at this time was 102°F., pulse 140 and respiration 60. The temperature rose to 105.8°F., her condition grew critical and she died on the ninth day of hospitalization.

The autopsy was made approximately thirty hours following death. Only the pertinent findings are included. Many dense fibrous adhesions were present around the gallbladder, some of these were continuous with the peritoneum in the area of the abdominal wall. Adjacent to the gall bladder and surrounded by fibrous adhesions were two small abscesses approximately 1 cm. in diameter. These were filled with a thick yellowish brown fluid. The wall of the gall bladder was greatly thickened except for the portion adjacent to the abscesses where it was paper thin. One black stone 2.5 cm. in diameter was present in the neck of the bladder.

The surface of this stone was granular. Mononuclear cells were conspicuous in the wall of the abscess. In the cytoplasm of some of these cells were numerous, small, fat vacuoles giving an appearance to the cell of a "foam cell." Numerous small masses of bile pigment were distributed throughout the inflammatory reaction.

The liver was small and showed a moderate amount of fat within the hepatic cells. There was a minimal amount of scarring about some of the portal triads. There was some arteriosclerosis throughout the body. A large amount of bronchopneumonia was present in both lungs.

Comment. The pathologic changes in the gallbladder were adequate to account for the clinical symptoms as observed in the abdomen. A history of a "gallbladder operation" twenty years previously and attacks of pain and nausea for several years previous to death were consistant with biliary disease. There was no history of jaundice and no retention of bile pigments during her terminal period of hospitalization.

The mental symptoms presented by this patient may have resulted from the cerebral arteriosclerosis, however, it is not an infrequent clinical observation to find elderly individuals showing neurologic changes in which it is difficult to determine their etiology. Bronchopneumonia developed during her last few days of life and may be considered to be the primary cause of death.

COMMENTS

These two cases are similar in that both occurred in obese, white individuals, one a male aged fifty-eight and the other a female aged seventy. One usually considers a malignancy at this age rather than choleliathasis; however, it should be remembered that Judd and Burden[2] found their largest percentage of cases of biliary fistulae occurred in the sixth decade of life. In a group of 153 cases one occurred in a patient between twenty and thirty years of age; seventeen were between thirty

and forty; forty-five were between forty and fifty; sixty-three were between fifty and sixty; twenty-five were between seventy and eighty. In neither of the two cases being reported is there a history of jaundice, however, in both there is a prolonged history of symptoms referable to the upper right quadrant.

A wide variety of pathologic curiosities associated with cholelithasis may be found in older publications.[1-3] Among these may be mentioned cases in which gallstones have been vomited from the stomach and coughed up from the larger bronchi. Gallstones have been found impacted in the male urethera and removed from the urinary bladder. Faber[4] records a case in which a woman voided thirteen gallstones with the urine.

Necrosis may be induced or hastened by pressure from a large biliary stone; however, local perforation may occur without a stone being present.[5] A gall bladder in which there is an impending perforation may attach itself to an adjacent viscus and establish a union between the two, permitting the stone to escape into the viscus. Unless the necrosed area is previously covered by adhesions a diffuse, frequently fatal peritonitis may result.[5] If the escaping biliary contents are small and non-infectious, a secondary walling-off may occur. A local abscess connected with a perforation in the gallbladder may rupture into parts of the peritoneum previously cut off by adhesions.[6] Robson[1] has emphasized the fact that the channel of a fistulae may be either direct, in which the two organs immediately communicate, or indirect,

owing to an abscess having formed and ruptured into a contiguous hollow viscus which then communicates indirectly through the abscess cavity. In the two cases reported herein an abscess formed from a perforation in the gallbladder; however, neither communicated with a second viscus. Recently Garland and Brown[7] discussed the roentgen diagnosis of spontaneous internal biliary fistulae.

SUMMARY

Two cases are reported of chronic cholecystitis, cholelithasis and perforation of the gallbladder. In the former a small sinus extended from the gallbladder to form a large subphrenic abscess on the left which extended down into the left colic gutter. Two small abscesses occurred adjacent to the gallbladder in the latter case. Abdominal and retroperitoneal abscesses may have their origin from the gallbladder and be difficult to diagnose at operation.

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New Instruments

PORTABLE UNIT
FOR PRONE POSITION SURGERY

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THE recent, rapid development of intrathoracic surgery has given rise to many improvements and innovations in the management of the patient when performing pulmonary resection and the technical procedures involved. Chief among these has been the popularization of the face down (prone) position. This was first advocated in 1944 by Overholt who has clearly outlined its advantages.[1] Since then, many surgeons have adopted this procedure.

In the lateral position, still used by many surgeons for intrathoracic operations, the diseased lung is uppermost, a condition which allows gravity drainage of secretions and débris to the good lung. In the prone position, however, especially with the diseased side slightly lowered, the chances of contralateral spillage are minimized and not infrequently by lowering the head of the table large amounts of discharge gravitate to the outside through the endotracheal tube. For this reason the face down position will prove most useful in cases of pulmonary surgery for diseases in which considerable intrabronchial suppuration occurs, e.g., lung abscess, bronchiectasis, malignancy with abscess formation, pulmonary conditions with associated bronchopleural fistula and empyema and tuberculosis with endobronchial disease and suppuration. In tuberculous cases the high incidence of spread of active disease to the normal lung following pneumonectomies and lobectomies will be decreased.

Further important advantages of the face down position are a marked diminution in the amplitude of mediastinal swing and lessening of its displacement as well as a better range of expansion for the normal lung. These factors are of especial importance for patients with marked impairment of pulmonary function and will eliminate cardiovascular embarrassment in many cases.

Despite these and other advantages of the prone position, its use on a standard operating table has proved impractical. When an anesthetized patient is placed face down on the firm, flat surface of such a table, the vital capacity is appreciably diminished due to the restriction of the diaphragmatic movements. This is a serious drawback since the maintenance of respiratory function is dependent upon the diaphragm chiefly, the thoracic muscles of respiration being paralyzed under surgical anesthesia. To overcome this difficulty many makeshift arrangements have been devised, and serious complications have resulted from the use of some of these, e.g., temporary unilateral or bilateral arm paralysis, low back pain, edema of the face and chest and traumatic bruises of the skin. Thus, the need for an apparatus which would offer surgeons all the advantages of operating in the prone position with none of the complications just mentioned has become increasingly apparent. In this regard Overholt and Comper have developed a special table for face down surgery
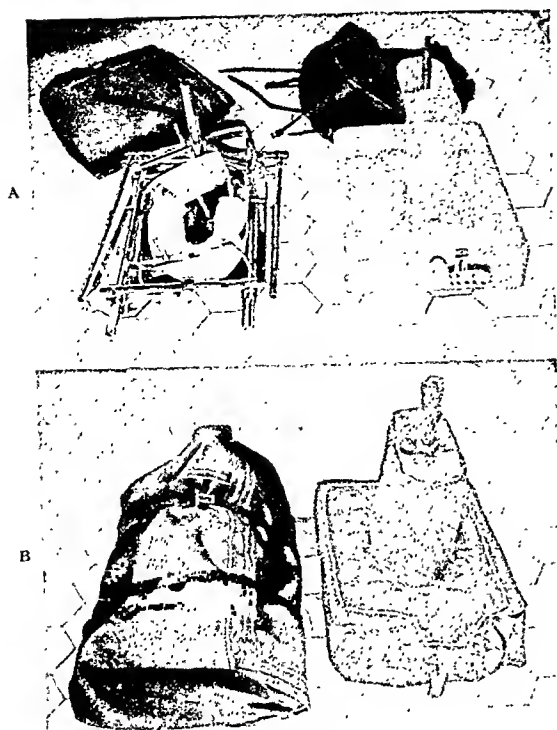
FIG. 1. A, the unit disassembled; B, ready for transportation.

which has proven satisfactory, and more recently the author has designed an apparatus for the same purpose which supports the upper part of the body while the pelvis and lower extremities rest upon a table. This is not an attachment to the table with incidental connections, but is a separate unit* in itself. Its chief advantages are its portability, ease of assembly and the fact that it may be used in connection with any standard operating table. (Fig. 1.)

The unit is briefly described herein and its special features outlined. It rests upon a floor base on which is mounted a hydraulic lift for height adjustment. It consists of three main parts: head rest, chest plate and arm supports. (Fig. 2.)

The head rest is well padded with foam rubber and is fully adjustable so that any desired degree of flexion, extension or lateral rotation of the head and neck may be obtained. It can also be quickly removed, of particular importance in the presence of an anesthetic problem.

* Manufactured by Cooperative Surgical Table Co., Brooklyn, N. Y.
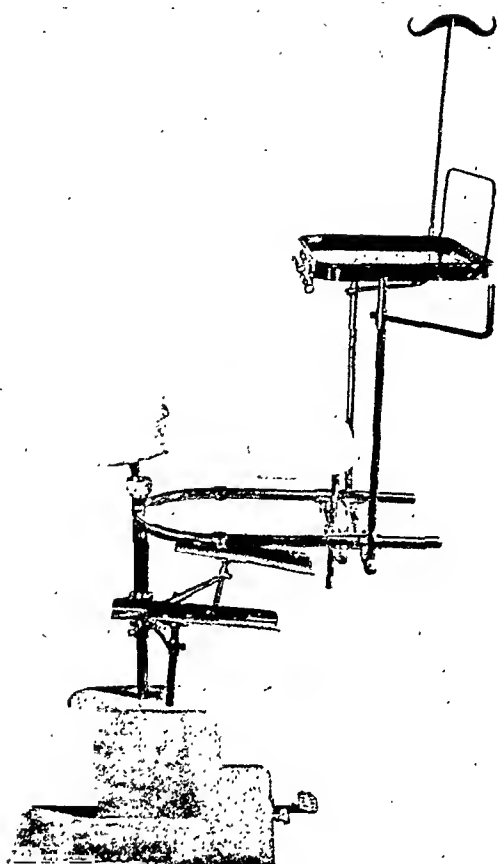
FIG. 2. The assembled unit with accessories in place.

The chest plate, also padded with foam rubber, is constructed in sizes to accommodate children and adults. It supports the clavicles and the upper part of the midthorax. A ball joint attachment permits the plate to deviate in various directions. Thus, the patient may be tilted to right or left if desired in order to prevent gravity drainage. In addition the angle of the chest may be easily accommodated lessening the possibility of postoperative pain and pressure areas. This can be done by increasing the angle of the chest plate as the height of the thorax approaches that of the pelvis.

The arm supports permit a full range of motion in all directions. This provides ample room for the surgeon and allows the scapula to be elevated and abducted, creating an excellent exposure of the operative field for transthoracic surgery when the posterolateral approach is used.
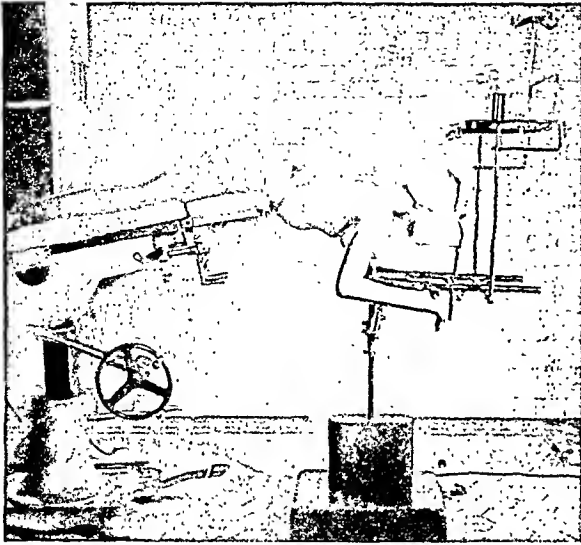
FIG. 3. A, the patient is shown in the operating position preparatory to lobectomy; B, same patient is shown draped; the line for incision is clearly visible.
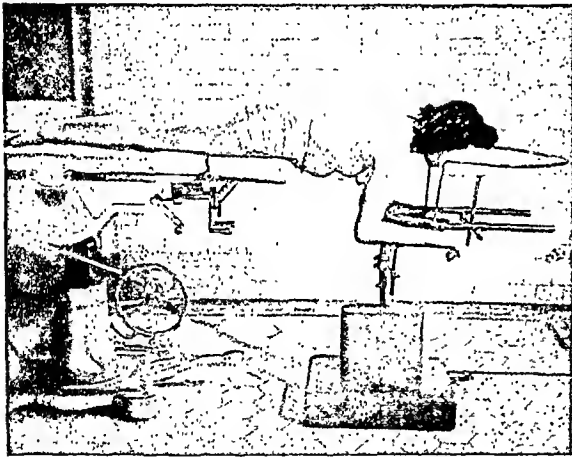
FIG. 4. Patient is shown in the operating position for upper spinal and intracranial procedures.

Removable accessories to the unit include an instrument tray, hooks for the suction tube, a fastener to prevent slipping of the endotracheal tube and holders for intravenous fluid therapy. (Fig. 3A.) The entire apparatus rotates on its base allowing the surgeon to place the patient in a position to best facilitate wound closure, (Fig. 1) of special importance when a portion of the chest wall is removed.

Support of the patient by the unit and the table (Fig. 3A) permits free and unrestricted movements of the abdomen and major portion of the thoracic cage, with only slight disturbance in vital capacity. In order to obtain the maximum efficiency of the unit with the resulting minimum ill effect to the patient the proper distribution of body weight must be achieved. This is dependent upon three variables: the angle of the chest plate, the tilt of the table and the difference in height between the table and chest plate.

The author has experienced excellent results with the patient in the position demonstrated in Fig. 3B. This shows a horizontal chest plate and a difference in height between the pelvis and thorax of approximately 6 inches. By placing the operating table in slight Trendelenburg the weight of the body on the chest and clavicles is greatly decreased.

The unit also may be used by orthopedic and traumatic surgeons for lumbar, dorsal and cervical spine procedures and by the neurosurgeon for certain intracranial operations. (Fig. 4.)

At the present writing the portable unit has been used for fifty-five thoracic operations over a period of eighteen months. These include pneumonectomy, lobectomy, exploratory thoracotomy, vagotomy, removal of a mediastinal tumor and repair of diaphragmatic hernia. At no time was

any complication evidenced as a result of its use. The author believes it to be highly satisfactory from the standpoint of the anesthetist as well as that of the surgeon.

SUMMARY

Advantages of the prone position for thoracic surgery are briefly discussed. A portable unit for this purpose is presented. Its chief advantages are that it can be easily transported and assembled and that it can be used with any standard operating table. The unit is described and its special features outlined.

Up to the present time the unit has been used for fifty-five thoracic operations and has proven to be most satisfactory.

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Correction: The authors of an article on "Lesions of the Large Bowel" published in our December, 1948 issue wish to call attention to an error appearing on page 651. Under the side heading, "Inflammatory Rectal Stricture," the number of patients examined from 1932 to 1945 should have read 1,134 instead of 11,134.

AN INSTRUMENT DESIGNED PRIMARILY FOR USE IN SURGICAL PROCEDURES ON THE AORTA*

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EXPERIMENTAL studies were begun in 1938 by Gross and co-workers with surgical correction of coarctation of the aorta as their goal.[1] Independently, Crafoord and Nylin[2] in Sweden and Blalock and Park[3] in this country attacked the problem in the laboratory, with the result that successful resection of the stricture and primary anastomosis of the thoracic aorta in human beings have been accomplished. Some time ago when O. T. Clagett and one of us (R. A. D.) began experiments to develop a surgical technic for the end-to-end suturing of the thoracic aorta, we were at once confronted with the difficulty of finding an instrument which could be used to occlude and manipulate the aorta without demonstrable trauma to the wall of the vessel. Similar difficulty had been encountered by Gross and Hufnagel. Eventually by modifying the straight gastroenterostomy clamp they developed a forceps that proved satisfactory.

The requirements of such an instrument are necessarily quite strict since the aorta must be occluded evenly and with just sufficient pressure to prevent the passage of blood beyond the clamp. The wall of the aorta is damaged easily and a region of relatively minor trauma makes possible the formation of a thrombus or the subsequent development of an aneurysm. Forceps with too strong a blade may even cut through the vessel. The resultant fragmentation of the wall would obviously preclude successful repair by suture. Our first models were derived from the Carrel, Allis, Delly, Ochsner and Doyen straight clamps. Profiting by the experience of Gross and Hufnagel, we fenestrated and grooved the blades of certain of the instruments. It was believed, however, that the variation in the size and physical characteristics of the aortas encountered demanded a greater range of adaptability than that offered by the box joint and rachet type of instrument. Furthermore, a finer adjustment would have the advantage of reducing to a minimum the damage to the wall of the vessel, particularly since some torsion and angulation of the aorta by means of the instrument is necessary during the operation. In the clamps mentioned previously, the occlusive pressure was the greatest next to the lock. This uneven bite occasionally allowed some slipping of the vessel unless sufficient pressure was used and this in turn appeared to endanger the wall of the vessel. Finally, there was always the danger of the forceps springing open during the manipulation.

Consequently, we designed a screw-type, parallel jawed clamp which would give an exact, delicately controlled pressure, distributed evenly across the vessel. The length of the shaft and slight angulation allow full control of the vessel, with a large range of rotation possible. These features have the additional advantage of getting the hands of the assistant out of the operating surgeon's field. To apply the instrument the lower nut and the lock nut are screwed so as to allow the blades to come apart. (Fig. 1a.) When the upper blade clears the short arm, it may be rotated to one side and the lower blade then may be slipped under the vessel. With the upper blade swung back into position, the clamp is screwed close to the desired degree. (Fig. 1b.) The blades have longitudinal grooving and are beveled on the sides to avoid their having a cutting edge. We operated on a
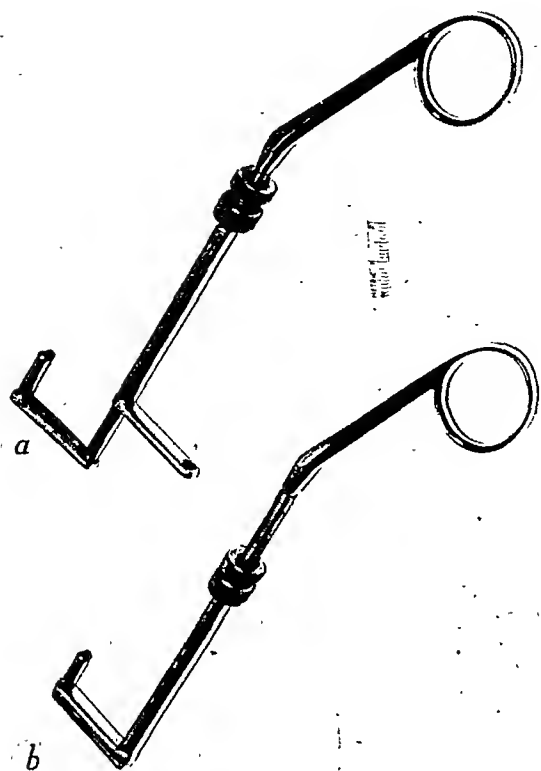
Fig 1. Illustration of instrument for surgery on the aorta.

number of dogs in survival experiments and in none was there demonstrable damage to the aorta in specimens examined between three and ten days after operation. It has not been necessary to cover the blades with cloth or rubber. A pair of these instruments with longer blades has been used success-fully by O. T. Clagett and one of us (R. A. D.) on patients having coarctation of the aorta.[4]

Placing a lateral curvature in the blades may facilitate holding the proximal aortic stump in those cases in which the coarctation is immediately below the origin of the left subclavian artery. Here there is almost no cuff of aorta available for an end-to-end suture to the distal aortic stump. Fortunately, this type of coarctation appears to be less frequently encountered than that occurring from 1 to 2 cm. distal to the origin of the left subclavian artery.

This type of instrument is also of value in the experimental surgery of the esophagus where control of the viscus in three planes is necessary during the operative procedure.

We wish to acknowledge the technical assistance of Mr. Dana Rogers.

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The Early Art of Surgery

I. THE EBERS PAPYRUS

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NOT so many years ago a German archeologist working in some ruins in Egypt was approached by a tall, swarthy, bearded stranger who winked an eye and announced that he had some treasures to sell. The archeologist took him over in a corner, where from under the folds of his robe the stranger produced various and sundry items of interest, none of which Ebers thought much of. Ebers was the name of the archeologist. It was now his turn to wink an eye at the secretive stranger and tell him that if he really had any treasures, and they really must be treasures, he was quite sure that they could do some business. The stranger left but announced that he would be back.

A couple of days later he returned, winked an eye again, and looked around with an air suggesting the need for the utmost privacy. Ebers took him off into a corner and his eyes must have popped when the stranger produced a scroll which he proceeded to unroll. Ebers was nobody's fool and he knew that he was looking at a real treasure. The only difficulty lay in who this fellow was and did he have any knowledge of the true worth of what he was showing, and above all how and where had he come by it.

The story goes that Ebers had to make some financial commitments in Leipzig before he became the possessor of this papyrus, for that is what it was.

Now while many papyrii exist in various museums throughout the world, most of them have faults and defects. Some consist of only a fragment of soiled page on which the characters are difficult to decipher. Others have been the victim of time and have been allowed to fall into a state of decay. Not so with the papyrus of Ebers. Its forty pages are clean, the characters are not dimmed and there is no sign whatever of any of the ravages of time. Ebers lost no time trying to merchandise his find. He offered it far and wide for a fabulous sum; and perhaps it was because he was so energetic and assiduous in trying to sell it, that it became known by his own name, the Ebers Papyrus, and why it is so much better known than any of the others.

The Ebers Papyrus consists essentially of many prescriptions and methods of procedure under the headings of various diseases. It is said that many of these remedies actually antedate by five hundred years their setting down in legible form; many of the formulas having been passed down by word of mouth from that time. There are sections which are of interest to the opthalmologist because many diseases of the eye and remedies for each are mentioned. For the gynecologist it describes many uterine displacements and formulas for types of douches. The obstetrician can find advice on what to do in different labors and in too free-flowing of blood during delivery.

Prescriptions for the prevention of baldness and for the growth of hair—most of them bizarre and repugnant to say the least—are given for the dermatologist.

The surgeon will find something on fractures and splints, on trephine operations for persistent headaches and epilepsy, on

The Ebers Papyrus

amputations and points of election for such, but nowhere will he find any description of suture, ligation or hemostasis. The internist will be interested to know that the diagnostician of 6,000 years ago was able to recognize that certain groups of symptoms invariably occurred together, and they are so described and classified. Physicians are designated by a special term which implies that they were to try to cure in a natural way internally and externally. No where is there a term for the one who did the amputations, cauterizations, etc.

There is much to delight the heart for the gastroenterologist and proctologist. The subject of pain in the right lower quadrant, gallstones and enlargement of the spleen in the upper left quadrant are touched upon as is also cancer of the stomach, jaundice and, last but not least, gastroptosis and enteroptosis.

Chronic constipation also plagued the physician of that day. These ancients knew of the castor bean and what it would do, and also prescribed both senna leaves and senna pods. An exceptionally capable presentation of the symptoms of both round worms and tape worms is given, and pomegranate seeds are prescribed for internal and rectal administration.

An illness of the abdomen, a "materia peccans," is described and its treatment is the thorough evacuation of the bowel, the sooner the better. Sitz baths are not at all new; the ancients used them for relief of hemorrhoidal symptoms 6,000 years ago. They knew and recognized rectal abscess, rectal fissure and fistulas, and multiple are the prescriptions for pruritus ani. An extract of juniper berries was recommended for cramps, particularly menstrual pain.

Many diarrhea prescriptions are given for the type which is with flatus and for that which is without.

"Twist in the bowel" or ileus, as we know it, is mentioned and active purgation (God forbid) is prescribed for it.

In a rough manner, this was the medicine and surgery of the oldest recording known to man. What better place to start from in order to record the additions and evolutionary processes which total up to the science as it is known to us today.

Editorials

FOLLOW-UP ON REPORTS OF PUBLISHED CASES OF MALIGNANT DISEASE

YEARS ago the writer was struck by the relatively large number of patients with malignant disease treated with irradiation whose cases had been reported in the literature with rather favorable results. But being of a suspicious mind he undertook by correspondence with authors of the case reports to ascertain the ultimate result in as many as possible of these published cases. It was distressing to find that the ultimate outcome had been so unfavorable in many of the cases reported favorably and particularly distressing to realize that the authors of these reports had not taken the trouble to publish a follow-up which would serve to correct the wrong impression.

A notable exception was a series of eight cases of carcinoma of the esophagus reported by W. M. Levitt.[1] In December, 1933 he showed to the Section of Laryngology of the Royal Society of Medicine seven of a series of eight patients with carcinoma of the esophagus treated during the previous nine months by a newly elaborated technic of deep x-ray therapy. All seven had had a high degree of esopha-

geal obstruction and all seven patients were able to swallow quite easily. They demonstrated their ability to swallow by eating sandwiches while being exhibited before the Section. Roentgenograms of these seven patients, which had apparently been successful, were shown and in all of them the roentgenographic evidence of the disease had disappeared. The eighth patient had died of empyema before treatment could be completed. Of course, it was hardly to be expected that the cure would persist in all of these cases, but the author hoped at least one or two of the patients would survive for a long time.

Before the same Section of the Royal Society of Medicine on March 3, 1944, Levitt[2] reported the subsequent history of these seven patients as follows: Five of them sustained as a result of their irradiation such damage to the pulmonary tissues that their deaths were ultimately caused by it and not by their growths. Four patients succumbed within a few months of acute infection from which they would have recovered easily had it not been for the lung damage. One lived nearly three years, dying of cardiac failure, with generalized

[1] LEVITT, W. M. Discussion on recent advances in treatment of carcinoma of the esophagus from surgical and radiological aspects, *Proc. Roy. Soc. Med.*, 27: 368–375, 1934.

[2] LEVITT, W. M. Discussion on the treatment of carcinoma of the esophagus. *Proc. Roy. Soc. Med.*, 37: 331–340, 1944.

edema and effusion into all the serous cavities. No trace of carcinoma could be found in the body at autopsy. One patient remained well for close onto five years although it was necessary to practice esophageal dilatation from time to time for fibrous stricture. He then suffered a recurrence which was fatal. The growth was in the upper third of the esophagus.

Had this matter been left as first reported the primary favorable report might have led, and possibly did lead, to some attempts to follow the same technic in the hope of obtaining the same good result recorded in the published record. Doubtless some such efforts occurred, but the author had the courage to make a later report on the same seven patients.

It requires courage to retract statements which have been honestly made after patient investigation and experience, but physicians should realize that many lives may depend upon the correction of the false impression and it should become a moral obligation to give a final report on published cases of apparent cure from malignant disease.

JAMES T. CASE, M.D.

COLOSTOMY PHOBIA

EVERY physician and surgeon at some time or other has patients consult him for the diagnosis and treatment of symptoms which demand a complete proctologic examination. When a malignancy is diagnosed, the question of treatment presents itself. In the vast majority of cases excision of the affected part of the colon is indicated. Depending on the location of the neoplasm is the selection of the site of the colostomy if one is proposed.

Surgical opinions have varied with the passage of time and the pendulum has swung from one extreme to the other. One group of proctologists and surgeons declare that under no circumstances should a carcinoma patient ever again be allowed to continue his bowel function through the normal outlet. Another group is equally vociferous in insisting that the sphincteric continence be preserved at all costs.

In our practice, we have always believed that one should fit the operation to the patient, instead of compelling the patient to adapt himself to the type of operation which we might favor. In any large proctologic practice a number of patients will be encountered who, when confronted with the necessity of major bowel surgery and colostomy life thereafter, are inclined to resist this advice because of some previous experience with people who have been colostomized. They seriously object to operative relief because of the fact that their friends' colostomies have either been improperly performed or they have not been properly trained in colostomy hygiene.

Some physicians seem to think that a colostomy, even though a life-saving measure, is something to be avoided at all costs and they certainly are not helpful in their counsel to prospective colostomy patients. In our practice we endeavor, so far as possible in those patients requiring abdominal colostomy, to place it at or as near the umbilical site as is possible. We believe that any device worn by the patient is less conspicuous there than if placed in the left lower quadrant.

In that very considerable number of patients in whom a perineal colostomy is feasible and which is desired by the patient there is very little likelihood of unpleasant leakage if the patient is properly trained in regard to irrigation and is put on a constipating diet.

In an increasing number of carcinoma patients in whom the lesion is above the middle of the rectal ampulla and is freely movable wide excision and immediate anastomosis can be performed. A pull-through operation with preservation of the sphincters is often the operation of choice.

It has been of great service to both prospective patients and to the proctologist to have the patient discuss the matter with people who possess a colostomy and, particularly, those who have been indulging in their normal occupation for several years.

It is interesting to note how anxious these people are to quiet the fears and apprehensions of those who are about to undergo operative procedures in which colostomy plays a dominant rôle. The word of mouth of the happy and satisfied patient who cares for his colostomy so that its presence is never suspected is of much greater value to the prospective colostomy patient than a sheet of printed instructions.

Medical men can be of great assistance and can save many lives by encouraging carcinoma patients as to the relative comfort and cleanliness of the life-saving colostomy.

LOUIS J. HIRSCHMAN, M.D.

Original Articles

INDICATIONS FOR PULMONARY RESECTION

SPECIAL REFERENCE TO EXTENT OF OPERATION

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AMONG the most notable of modern surgical advances has been the development of thoracic surgery under the leadership of a few pioneers such as Dr. Evarts Graham. In this field there are probably no greater successes than those obtained through the resection of lung tissue. Pulmonary resection may be performed as the removal of an entire lung (pneumonectomy); the removal of one or more lobes of one or both lungs (lobectomy, unilateral or bilateral); the excision of a bronchopulmonary segment of one or more lobes (segmental resection); or the resection of a portion of a lung smaller than a bronchopulmonary segment (local excision). The advent of pulmonary resection has unquestionably revolutionized the modus operandi of chest diseases and today patients suffering from primary malignancy, bronchiactasis, certain tuberculous lesions and numerous other chronic pulmonary conditions have an excellent chance of becoming completely well.

Formerly, primary carcinoma of the lung was invariably fatal. To establish the diagnosis was to pronounce the patient's death sentence. Also presenting an almost hopeless problem were certain cases of pulmonary tuberculosis, especially those with bronchial occlusion. Bronchiectasis is another condition which has had no satisfactory solution. Before the advent of bronchography it was frequently unrecognized and numerous cases were incorrectly diagnosed as unresolved pneumonia. In addition many of these patients were admitted to sanatoria with the mistaken diagnosis of pulmonary tuberculosis. In spite of the periods of remission that often accompanied medical treatment, the course was practically always in a downward direction. The majority of sufferers were doomed to chronic or recurring invalidism and many became social outcasts because of their paroxysmal cough and associated expectoration of copious amounts of fetid sputum. Results of a review of 400 patients conducted by Perry and King[1] demonstrate that over a period of twelve years the mortality rate in non-surgically treated patients was 26 per cent, 41 per cent of the patients dying within five years of the onset and 15 per cent living twenty years or longer after the onset. In the fatal cases 78 per cent of the patients died directly of the disease. Pulmonary abscess together with neoplasm has also been one of the most serious diseases of the lung. The mortality rate in reported cases ranged from 30 per cent to 50 per cent.[2] Many patients who did not die in the hospital remained chronic pulmonary invalids and were doomed to an early death from "pneumonia" or a less common complication, namely, hemorrhage, brain abscess or asphyxia.

However, since 1933 when Graham performed the first successful total pneumonectomy for carcinoma, progress has been such in intrathoracic surgery that today pneumonectomies and lobectomies are no

longer unique operations. With the application of the numerous advances in the pre- and postoperative management of the patient and the carefully worked-out surgical technic now applied, they have become adopted as routine procedures with minimum risk. The mortality in a collected series of pulmonary resections[3] performed between 1931 and 1938 was shown to be 65 per cent in the malignant group and 24 per cent in the benign group. In another series for primary bronchogenic carcinoma[4] the hospital mortality rate in the earlier cases before 1941 was 45.4 per cent, whereas in thirty cases since 1941 the hospital mortality rate was 6.6 per cent. It is generally accepted that today the mortality rate for all surgically treated pulmonary carcinoma varies from 5 per cent to 10 per cent. These figures compare favorably with those pertaining to total resection of abdominal organs for malignant conditions and are certainly not prohibitive when it is realized that the disease is 100 per cent fatal without surgical treatment. Exploratory thoracotomy is on a par with abdominal exploration regarding safety and accuracy. It is a procedure responsible for effecting an increasing number of cures in the treatment of lung carcinoma. In the surgical treatment of bronchiectasis some clinics have as low as 1 per cent mortality.

The foregoing facts assert the need for general acceptance of the fundamental concepts governing the diagnosis, evaluation and therapy of intrathoracic lesions. Although the entire subject cannot be covered here, it is the purpose of the author to present some fundamental principles and outline the chief indications for pulmonary excision with a brief discussion as to the extent of operation.

FUNDAMENTAL PRINCIPLES GOVERNING THE REMOVAL OF LUNG TISSUE

The principles involved in the removal of pulmonary tissue are simple and obvious. Applied to carcinoma the procedure is basically the same as that accepted for the treatment of gastric, colonic, rectal and mammary lesions of a similar nature. Today surgeons agree upon the removal of the entire organ which contains the cancerous lesion together with its regional lymph nodes and the intervening lymphatics. Pneumonectomy with the resection of mediastinal glands meets these basic surgical requirements offering a chance of cure to certain patients and palliation to others. A prerequisite of treatment should be the use of convincing argument and persuasion that only prompt intervention can achieve the best results.

The principle of extirpating a disease process has been successfully applied in certain conditions such as appendicitis and cholecystitis. Similarly, this has proven most successful in the treatment of chronic suppurative diseases of the lung. The principles of drainage of pulmonary abscesses are essentially those which apply to an abscess in any other location. These principles are early and adequate drainage of the process with as little disturbance of surrounding normal structures as possible. However, the conventional thoracotomy for drainage of a chronic lung abscess frequently has not produced satisfactory results. For this reason there is a growing feeling among thoracic surgeons that a large number of these patients can be treated more satisfactorily by lobectomy than by thoracotomy.

As a result of anatomic studies and increased surgical experience, it has recently been demonstrated that the bronchopulmonary segment (Fig. 1) is a surgical unit and lends itself to removal without undue technical difficulties or risk.[5-7] Applied to bronchiectasis this concept forms the basis of the outstanding form of treatment for selected patients with disease in both lungs. These anatomic units are best removed with the retrograde technic similar to performing a retrograde cholecystectomy.

In certain other conditions, such as benign tumors and emphysematous bullae, local excision may suffice. Removal of an

anatomic unit by pulmonary segmental resection or a portion of lung by local excision permits the accomplishment of one of the major principles in pulmonary surgery, namely, the preservation of as much competent functional tissue as possible.

These fundamentals demand of the
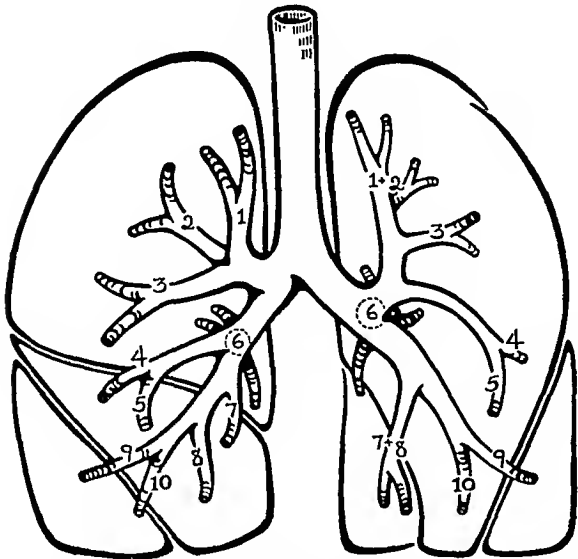
FIG. 1. Schematic representation of the bronchial tree. The number of each branch corresponds to that of the pulmonary segment which it supplies. The Jackson-Huber nomenclature listed below is based upon the position of the segment within each lobe.

RIGHT LUNG

LOBES	SEGMENTS	
Upper	Apical	1
	Posterior	2
	Anterior	3
Middle	Lateral	4
	Medial	5
Lower	Superior	6
	Medial Basal	7
	Anterior Basal	8
	Lateral Basal	9
	Posterior Basal	10

LEFT LUNG

LOBES	SEGMENTS		
Upper	Upper Division	Apical-posterior	1 & 2
		Anterior	3
	Lower (Lingular) Division	Superior	4
		Inferior	5
Lower		Superior	6
		Anterior-medial Basal	7 & 8
		Lateral Basal	9
		Posterior Basal	10

thoracic surgeon a most careful appraisal of the patient. Usually he is able to estimate preoperatively the amount of tissue to be excised but in some cases this becomes evident only upon entry into the pleural cavity. In most patients the matter of residual respiratory function presents no problem but in others it will be an important factor in determining the extent of resection.

INDICATIONS FOR PULMONARY RESECTION

Removal of an entire lung or portion of a lung is indicated in certain conditions in which the pulmonary tissue is so seriously diseased that its retention will either interfere with the well being of the patient or cause his death. These conditions may be classified as follows:

  I. Primary New Growths of the Lung
        A. Malignant
              1. Carcinoma
              2. Sarcoma
        B. Non-malignant
 II. Metastatic "Solitary New Growths"
III. Chronic Suppurative Disease
        A. Bronchiectasis
        B. Lung abscess
        C. Gangrene of the lung
        D. Chronic pulmonary disease with varying degrees of atelectasis, pneumonitis and abscess formation (which do not clearly fall into the classification of either bronchiectasis or lung abscess)
        E. Chronic non-specific pneumonitis
 IV. Tuberculosis
  V. Fungus Infections
 VI. Pulmonary Cysts
        A. Non-parasitic cysts and cyst-like cavities
              1. Congenital pulmonary cyst
              2. Cystic bronchiectasis
              3. Epithelialized cavities following pulmonary suppuration

4. Pneumatocele (localized alveolar or lobular ectasia)
5. Emphysematous bullae
6. Pulmonary blebs

B. Parasitic cysts
    1. Echinococcic (hydatid) cyst

VII. Arteriovenous Fistula

VIII. Traumatic Injuries

COMMENTS WITH SPECIAL REFERENCE TO
EXTENT OF RESECTION

Malignant New Growths. At the present time carcinoma of the lung constitutes the chief indication for pneumonectomy. This condition, formerly considered rare, has been known to rank third as a cause of death due to cancer, being exceeded only by carcinoma of the stomach and carcinoma of the bowel. Recently Graham stated that it now ranks first. Today this dread disease causes approximately 16,000 deaths per year, being responsible for 10 per cent of all deaths from malignant tumors. Since tumors cause 10 per cent of all deaths it can be seen readily that each one of us runs a one per cent chance of acquiring a primary bronchogenic carcinoma. This condition is so common that any male patient past the age of forty who develops a chronic cough with expectoration of mucoid material not containing tuberculous bacilli should be considered as having primary malignancy of the lung until proven otherwise.

Primary carcinoma of the lung is bronchogenic in origin. Thus, the signs and symptoms are the results of three processes: local irritation and destructive processes in the bronchus itself, varying degrees of bronchial occlusion and secondary changes in the lung parenchyma. This disease simulates many other chest conditions. Approximately 60 per cent of the patients harboring pulmonary malignancy are not only incorrectly diagnosed by the first doctor consulted but treatment based upon this erroneous diagnosis is usually maintained for long periods of time.

There are no characteristic roentgen features of bronchogenic carcinoma for it may simulate all types of lesions such as tuberculosis (Fig. 2), bronchiectasis, lung abscess (Fig. 3), benign tumor (Fig. 4), pneumonia (Fig. 5) and pleural effusion. Le that as it may, roentgenography is still the greatest single diagnostic aid at our disposal and it should suggest the diagnosis in the vast majority of cases. X-ray manifestations depend upon the following factors: type and location of the tumor, degree of bronchial occlusion, presence of parenchymal infection and occurrence of mediastinal or chest-wall extension. The entire shadow may be cast by the tumor itself when the peripheral lesion arises distally in the bronchial tree. (Fig. 4.) A tumor arising in a primary or a secondary bronchus (central lesion) does not cast a distinctive shadow of its own but one of atelectasis. (Fig. 6.) In malignancy of the hilar region a shadow of the tumor itself is cast in a small number of cases. (Fig. 7.)

Medical treatment for primary malignancy of the lung is only palliative. Radiation therapy is not only futile but for some patients it increases the severity of the symptoms and thoracic pain seems to become more acute. An early diagnosis and surgical removal offer the only chance for cure. In most cases this means total pneumonectomy together with extirpation of the mediastinal lymph nodes. In rare cases, notably peripheral tumors, cure can be obtained by simple lobectomy. During exploratory thoracotomy in a questionable case of lung carcinoma the assistance of a pathologist will aid the surgeon in making an accurate diagnosis.

Sarcoma of the lung is a relatively uncommon tumor and is treated by surgery similarly to carcinoma.

Non-malignant New Growths. A question of importance regarding the use of total pneumonectomy for new growths concerns the best method of treating bronchial adenoma. This tumor which accounts for approximately 80 per cent of benign bronchogenic growths is still the

FIG. 2. Bronchogenic carcinoma of right upper lobe simulating pulmonary tuberculosis.
FIG. 3. Bronchogenic carcinoma of left upper lobe with secondary lung abscess (lateral view).
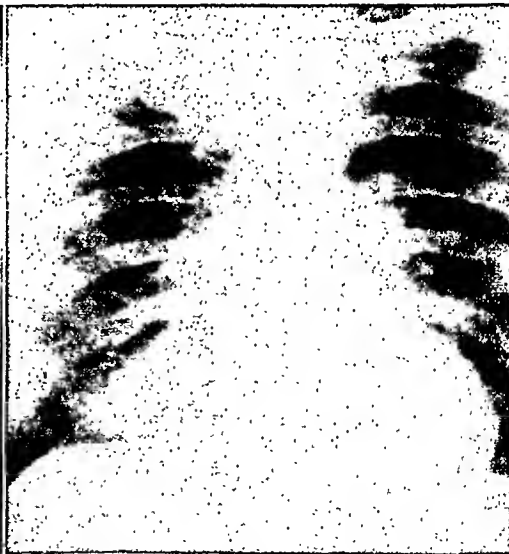
FIG. 4. Peripheral malignant neoplasm of right lower lobe simulating a benign lesion (right anterior oblique).
FIG. 5. Bronchogenic carcinoma with secondary segmental atelectasis and diffuse pneumonitis of the right lobe simulating pneumonia.

subject of much controversy. The indecision is due chiefly to accumulated evidence toward consideration of these tumors as potentially invasive and malignant. In a recent discussion Alexander stated that the pathologist, Weller, has insisted for many years that this condition is a grade 1 carcinoma.[8] Nevertheless, it is regarded by many as essentially benign. A review by Langer and the author[9] of fifteen bronchial adenoma and 305 carcinoma patients treated by Overholt indi-
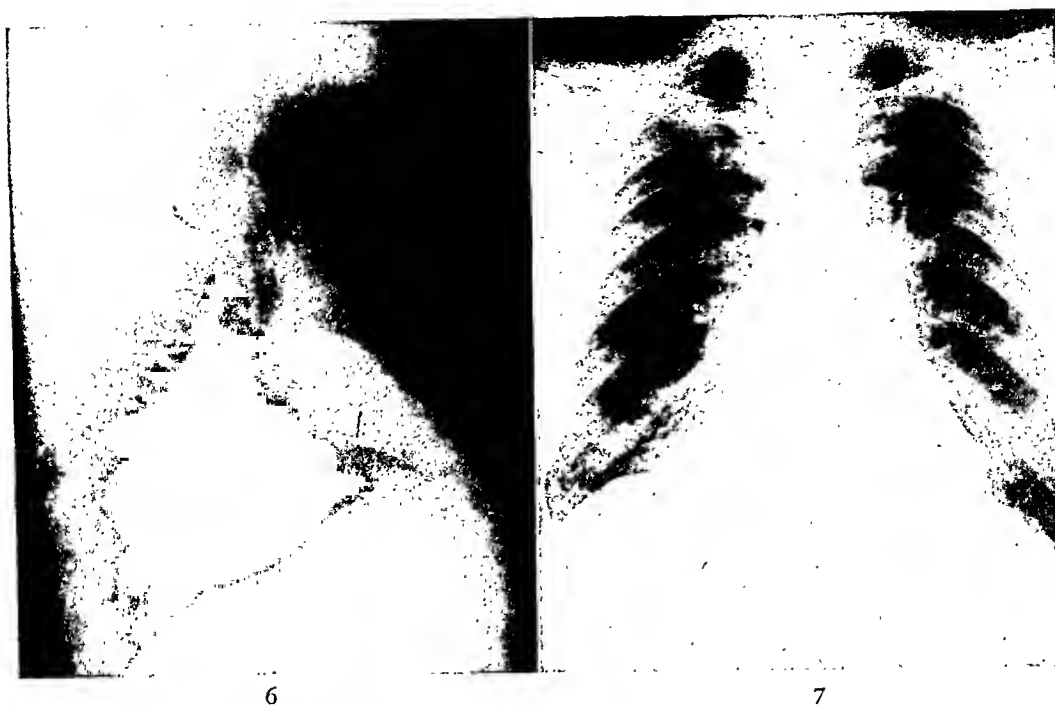
FIG. 6. Bronchogenic carcinoma of the middle lobe bronchus giving rise to atelectasis (lateral view).
FIG. 7. Bronchogenic carcinoma visible at left hilum.

cates that these conditions should be considered as different and essentially benign rather than as belonging to two grades or stages of the same neoplasm. The salient differences are shown in Table 1.

Regardless of their benign or malignant character, the early diagnosis of these tumors is of importance because they cause bronchial obstruction with subsequent bronchiectasis, pulmonary abscess or empyema. In many patients hemoptysis is the chief symptom. For this reason some patients are sent to sanatoria with the diagnosis of tuberculosis. Other symptoms are those of endobronchial blockage, i.e., wheezing, productive cough and dyspnea.

Bronchoscopic removal was the treatment usually employed in the past for patients in whom there was no serious damage distal to the growth. However, this method of treatment is used less commonly at the present time for the following reasons: local recurrences, danger of serious hemorrhage and inability to remove adequate amounts of the tumor (the portion of the tumor outside the bronchus is often larger than the intraluminal portion). Pulmonary resection is, therefore, indicated.

Lobectomy is usually adequate except when the situation of the adenoma necessitates pneumonectomy.

Less common benign tumors of the lung include papilloma, fibroma, hemangioma, harmatoma, lipoma, osteoma, myoblastoma and angioma. They may occur at any age but are often asymptomatic until the third or fourth decades. The roentgenologic and diagnostic problems are sometimes quite similar to those associated with pulmonary carcinoma. These tumors possess the features of benign tumors elsewhere in the body, i.e., they are encapsulated and lack the invasive properties of malignant tumors. However, intrathoracic malignant tumors frequently cannot be distinguished from benign conditions by available diagnostic methods. Lobectomy is the treatment of choice in dealing with these neoplasms. In some instances local excision will suffice while in other cases segmental resection should be considered.

Metastatic "Solitary New Growths." Metastatic tumors of the lung are extremely frequent and are associated with many diagnostic difficulties. Clinically and roentgenologically, they may mimic tu-

berculosis, pneumoconiosis and primary tumor of the lung. Involvement of both lungs is common precluding surgical removal for obvious reasons. However, "solitary" pulmonary metastases do occur and may be indistinguishable from a

frequently, multiple bronchopulmonary segments in both lungs. (Fig. 11A and b.)

Surgical removal of the affected part constitutes the only curative treatment. In properly selected cases cure is practically certain; whereas if untreated, the disease

TABLE I

SALIENT FEATURES OF BRONCHIAL ADENOMA AND BRONCHOGENIC CARCINOMA

	Bronchial Adenoma	Bronchogenic Carcinoma
Average Age	37.4 yr.	53.2 yr.
Sex	Male to female—1:1	Male to female—3.8:1
Average duration of disease before surgery is instituted	5.9 yr.	11.3 mo.
Clinical picture	Hemorrhages, often profuse, with sudden onset and termination; intermittent episodes of pneumonitis with healthy intervals; bronchiectasis common	Hemorrhages usually blood streaked and continuous; progressive secondary pulmonary complaints without healthy intervals
X-ray findings	Tumor frequently not visible; only shadows incident to obstruction are seen	Tumor frequently is seen
Bronchoscopic picture	Often pedunculated, small, pink, or yellowish in color; carina always sharp and mediastinum free; biopsy frequently followed by bleeding	Usually irregular, fungating, ulcerogranulomatous, non-pedunculated, gray or grayish-yellow; carina frequently blunted and mediastinum fixed; bleeding minimal
Metastases	Occasionally regional lymph nodes; rarely distant	Regional and distant metastases frequent
Amenability to surgical cure	Almost 100%	10%
Survival	Long duration	Short duration

primary growth. (Fig. 4.) Surgical treatment of the solitary lung metastasis is indicated in specific instances.[10] If the primary malignancy has been removed and a solitary lung lesion is the only sign of metastatic disease, resection of the lung (either lobectomy or pneumonectomy) appears to be justifiable.

Bronchiectasis. Within the past quarter century our knowledge of bronchiectasis has increased extensively. This has been due chiefly to the advent of iodized oil bronchography which is now a precise and easily applied method of diagnosis. Its wider use has revealed bronchiectasis to be a common disease which, in the opinion of many, ranks second only to tuberculosis among chronic diseases of the chest. It may involve a whole lung (Fig. 8), one lobe (Fig. 9), two or more lobes, a bronchopulmonary segment (Fig. 10) or, more

process is irreversible, progressive and usually fatal. Conservative methods are essentially palliative and for the most part ineffective. Operative mortality is much less in children and young adults than after middle age, an important point in favor of operating soon after the diagnosis has been established.

Pneumonectomy is clearly indicated when there is extensive involvement of all lobes in one lung. When the lesions are limited to one or two lobes, lobectomy should be performed. Patients with extensive bilateral disease were formerly denied surgery. Today, however, due to the development of and the refinements in segmental resection, they are candidates for palliation or cure. This operation allows the conservation of a maximum amount of competent respiratory tissue not possible when entire lobes are removed. In
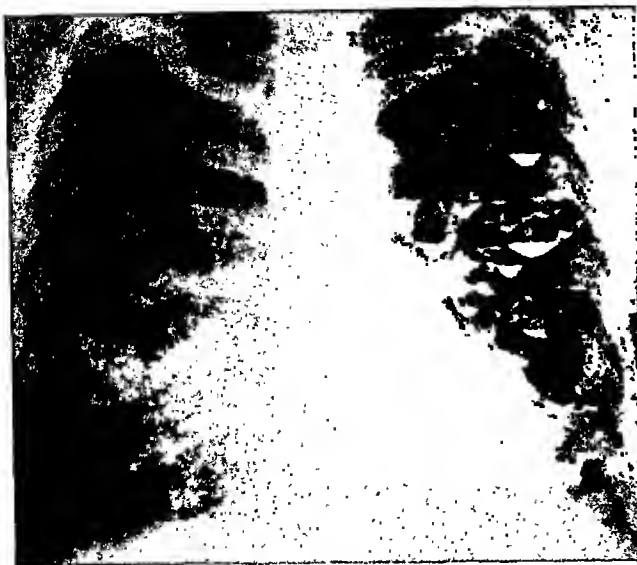
FIG. 8. Bronchiectasis of entire left lung.
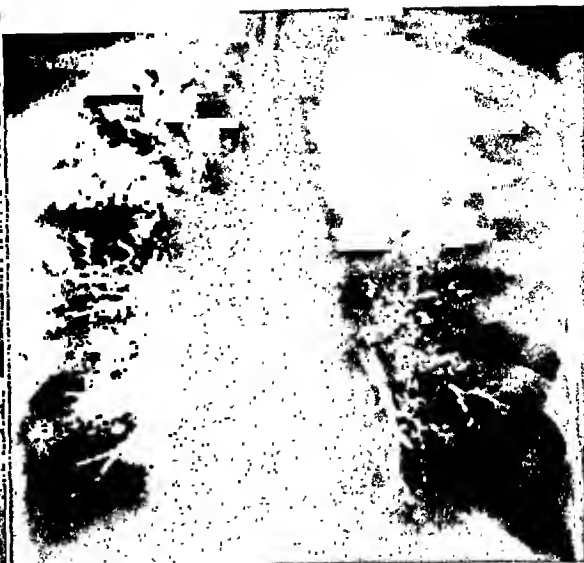
FIG. 9. Bronchiectasis of right upper lobe.

unisegmental unilobar disease the question arises as to whether this principle of segmental resection should be applied or whether a lobectomy should be performed. In the opinion of the author a lobectomy is the preferred treatment for the following reasons: (1) The operation is less difficult to perform. (2) There are fewer postoperative complications (atelectasis, bronchopleural fistula, empyema). (3) The problem of pulmonary reserve will rarely become a determining factor.

Chronic Lung Abscess, Pulmonary Gangrene and Unclassified Conditions. Other chronic suppurative diseases of the lung amenable to resection are abscess, gangrene and other diseases with varying degrees of atelectasis, pneumonitis and abscess formation which do not clearly fall into the classification of either bronchiectasis or lung abscess.

It is extremely difficult and sometimes impossible to make a differential diagnosis between lung abscess and pulmonary gangrene. In either case one is dealing with destruction of tissue and for this reason there is a tendency today to consider the two conditions together. The term pulmonary gangrene is ordinarily applied to a massive necrosis of lung tissue without tendency to localization.

FIG. 10. Bronchiectasis of the basal division of right lower lobe.

This disorder is much less frequent since the advent of antibiotic agents. Secondary infection of the contents of a simple purulent abscess may lead to spreading gangrene. On the other hand, some cases of gangrene of the lung become limited and after expectoration of necrotic tissue, the anaerobic infection subsides and a simple abscess remains.
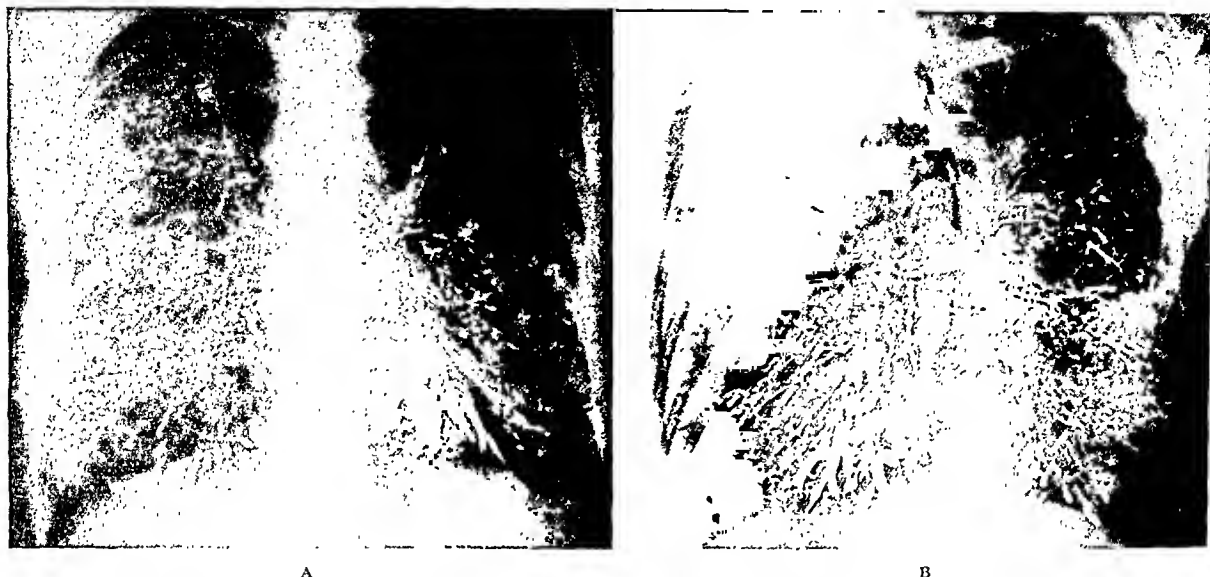
FIG. 11. A, postero-anterior view., B, right anterior oblique view. Bronchiectasis of the basal divisions of the right and left lower lobes, the right middle lobe and lingular division of the left upper lobe.

There is also a fine differentiation between chronic, multiple lung abscesses with bronchiectasis and chronic bronchiectasis with abscess formation. These suppurative disorders are best managed by surgical removal, the extent of resection being dependent upon the amount of diseased tissue.

Satisfactory results obtained today in the treatment of lung abscess are accounted for by the improvement in the technic of drainage operation, the more prompt application of surgery and, particularly, the utilization of lobectomy.

Indications for surgical excision in the treatment of this condition are: (1) when the disease is chronic with associated lung damage (fibrosis, bronchiectasis, atelectasis). The chronicity of the case constitutes the most frequent indication; (2) when multiple cavities exist in one or more lobes; (3) when there is persistent disease following drainage operations; (4) when a bronchogenic neoplasm is suspected as an underlying cause; (5) when the lung abscess is associated with a retained foreign body; and (6) in children. Postoperative care of drainage procedures is notoriously difficult for these patients and many develop bronchiectasis following drainage, whereas lobectomy is well tolerated by children.

Chronic Non-specific Pneumonitis. Chronic, non-specific pneumonitis is characterized by a diffuse, chronic, inflammatory process with marked fibrosis associated with narrowing of the bronchi and atelectasis. It is difficult at times to differentiate between this condition and carcinoma. Ten cases of chronic, non-specific pneumonitis were reported by Adams and Kershner and other similar cases by various authors,[11] all of whom demonstrate clearly the success of treatment by resection.

Tuberculosis. During the past few years sufficient experience has been accumulated to make possible the prediction that pneumonectomy and lobectomy are likely to have an important place in the surgical treatment of pulmonary tuberculosis. Time and further experience will establish more definitely their proper place in the general scheme of treatment and will determine the particular lesions for which they are most suitable. Thus far, however, most thoracic surgeons agree that indications for pulmonary resection in tuberculous cases include (1) cavities failing to close under an adequate thoracoplasty; (2) extensive bronchial stenosis; (3) tuberculous bronchiectasis; (4) tuberculoma; and (5) cavities in the lower lobe so situated that no form of collapse therapy will cause their

closure. More recently[12] pneumonectomy with pleurectomy has been successfully performed for unilateral tuberculosis with mixed infection, tuberculous empyema and bronchopleural fistula. Lloyd and the author obtained an excellent result with pleurectomy and pneumonectomy in a case of empyema necessitatis in addition to unilateral tuberculosis with mixed infection empyema and bronchopleural fistula.[13] It is generally thought that the selection of surgical cases has been widened through the use of streptomycin to include those of a more complicated and desperate nature.

It should be emphasized that the aforementioned procedures are not in competition with any of the standard collapse measures but provide a hope of cure to that group of patients who are obviously not candidates for collapse therapy or for whom such treatment has failed.

Fungus Infections of the Lung. Excisional therapy has its place in the treatment of fungus infections of the lung. Conservative measures have proved unsatisfactory, for the most part, in the treatment of bronchopulmonary actinomycosis although some success has been reported following sulfonamide and penicillin therapy. These agents are generally of no avail. In such cases healing will occur only after resection of the diseased tissue by lobectomy or pneumonectomy.

Pulmonary coccidioidomycosis in its usual mild form generally subsides in two or three weeks. The chronic form frequently runs a benign course producing slight disability in the majority of patients. In some more severe cases, however, cavitation may occur and in others a granulomatous type of infection takes place. As yet there is no specific treatment. In occasional cases surgery is indicated; if abscess formation occurs, drainage may be considered. However, the frequent presence of daughter granulomas has made lobectomy a preferable procedure, especially in the presence of cavitation.[14] Resection is indicated in cases in which

recurrent hemoptysis is a prominent feature and when the usually fatal granulomatous type of infection exists.

Pulmonary Cysts. Pulmonary cysts comprise some of the most interesting abnormalities of lung tissue. They are of special interest because the term "pulmonary cyst" has been used to designate a wide variety of pathologic entities. The lesions involved in this group are: congenital pulmonary cyst; cystic bronchiectasis; epithelialized cavities following pulmonary suppuration; pneumatocele (localized alveolar or lobular ectasis); chronic interstitial pneumonitis with emphysema; emphysematous bullae; pulmonary blebs and echinococcic (hydatid) cyst.

The presence or absence of an epithelial lining in these lesions controls the symptomatology and for the most part dictates the treatment. Epithelialized cysts are best treated by pulmonary resection similarly to bronchiectasis and chronic abscess. Pulmonary cysts not lined with epithelium, i.e., emphysematous blebs and bullae, are not generally understood. A thorough knowledge of the existing condition and associated alteration in the physiodynamics of the chest is necessary in planning the best type of therapy. In some cases pulmonary blebs and bullae, even when large, can be asymptomatic and frequently will disappear spontaneously. These patients are obviously not candidates for surgery. In other cases in which there is obstruction to the egress of air in the bronchus (check valve mechanism) the cyst will balloon out and acquire large dimensions, in extreme cases filling the larger portion of both pleural cavities and causing incapacitating dyspnea. Until a few years ago there had been no satisfactory treatment for this condition. Today various procedures are used. Head and Avery[15] recently reported upon fifteen patients with large emphysematous bullae and two with bronchogenic cysts who were greatly benefited by intracavitary (Monaldi) suction. Others have experienced good results with lobectomy and
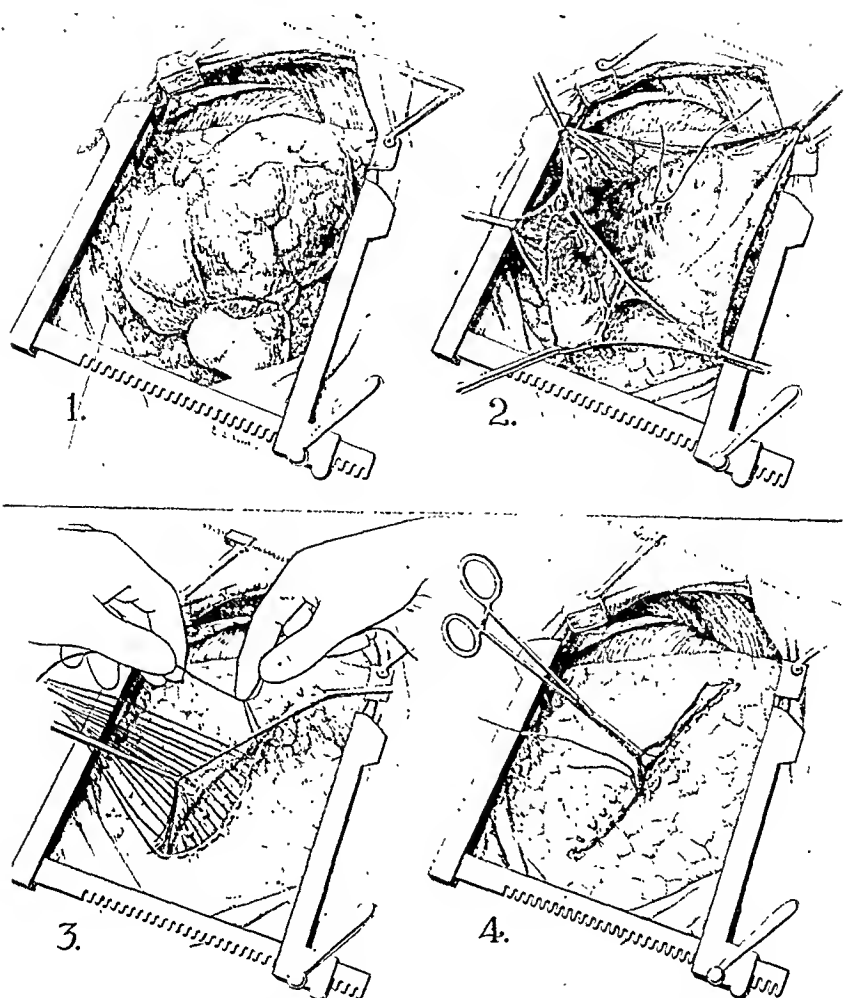
FIG. 12. Local excision technic. 1, Pulmonary cyst visualized through operative incision; 2, closing suture over bronchial orifice; 3, imbricating sutures in visceral pleura; 4, final closure with interrupted black silk. (Courtesy of *Surgery*, 22: 516–564, 1947.)

pneumonectomy. Langer and the author[16] described the use of local excision technic with excellent results. (Fig. 12.) This procedure is contraindicated, however, in the presence of an epithelial lining. In cases in which a low respiratory reserve exists the use of intracavitary suction may prepare the patient for thoracic exploration and definitive surgical therapy.

Pulmonary hydatid disease may also constitute an indication for pulmonary resection. When spontaneous expectoration and evacuation is present, healing may occur without complications. In patients in whom secondary infection of the cyst with abscess formation is seen, the condition should be treated as a pulmonary abscess. Lobectomy offers the only chance for cure when repeated hemoptysis occurs and may be considered in the presence of many scattered cysts in one lobe.

Arteriovenous Fistula. The diagnosis of arteriovenous fistula in the lung may be difficult because the presence of symptoms depends largely upon the extent of communication and the volume of blood passing through. Many patients are without symptoms but this diagnosis should be considered whenever cyanosis, clubbing of the fingers and polycythemia are present. Hemoptysis may be the first and only symptom; angiocardiographs are necessary to confirm the diagnosis. Treatment of this condition consists of surgical interruption

of the fistula or excision of the vascular mass. Because of the difficulties associated with ligating the communication between the artery and the vein, local or segmental resection is the procedure of choice. In most patients, however, lobectomy or pneumonectomy is necessary because of the size and location of the vascular channels. Maier[17] has pointed out that because of the possibilities of associated vascular anomalies, one should be certain that adequate channels remain for the return of blood to the left side of the heart.

Traumatic Injury to Lung. In the case of perforating or penetrating injuries to the lung conservative measures are usually sufficient. Occasionally, however, it is imperative to enter the chest whereupon segmental repair and local excision may suffice. If a hematoma exists which is of sufficient size to involve an entire lobe, a lobectomy is indicated. In the event of an expanding hematoma which threatens to perforate, either lobectomy or pneumonectomy is advisable depending upon the location of the hematoma. Occasionally damage may be so extensive that pneumonectomy offers the only hope of controlling hemorrhage and shock. Emergency thoracotomy must be performed in some instances of closed pneumonolysis when early massive subcutaneous emphysema with tension pneumothorax or profuse hemorrhage into the pleural cavity occurs. Treatment may then consist of segmental repair, local excision or resection.

SUMMARY

1. The fundamental principles governing the removal of lung tissue are stated.

2. The various conditions are discussed with respect to factors determining the extent of resection.

3. An outline of indications for pulmonary resection is presented.

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DIAPHRAGMATIC HERNIA*

A REVIEW OF THE LITERATURE AND REPORT OF TWO UNUSUAL CASES

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THE number of publications which have appeared during recent years attest to the current interest among internists, roentgenologists and surgeons in the many problems relative to diaphragmatic hernia. As a consequence of these studies and in particular along with the development of more improved roentgenologic methods applicable to the diagnosis of diaphragmatic hernia, there has been an apparent increase in the incidence of this condition. In 1924 Rendich reported 202 cases in a series of 5,033 gastrointestinal roentgenologic studies, an incidence of .04 per cent. However, the reported occurrence has risen to 2 per cent and above in most of the larger series. Case records at the Ohio State University Hospital have shown a similar increased incidence of diaphragmatic hernia in recent years.

In view of the frequent occurrence of this entity and the varied and complex symptoms produced by it, the clinician must often consider diaphragmatic hernia, usually the non-traumatic type, in the differential diagnosis of many respiratory, circulatory and gastrointestinal diseases. Once the diagnosis is made, a concomitant disturbance as the prime cause of the patient's symptoms must be ruled out. Following arrival at a definite diagnosis, conservative versus surgical management must be decided upon. Finally, the surgeon must determine the optimum time of repair, choose between a transperitoneal or a transpleural approach, be able to cope with the technical difficulties of adequate exposure and determine the type of repair

indicated. He must always be aware of traumatic rupture of the diaphragm when evaluating accident cases.

There is an excellent likelihood that we may be faced with an even greater incidence of the traumatic types of diaphragmatic hernia, secondary to direct or indirect injury of the diaphragm. First, due to the progressive character of certain types, many former G.I.'s who suffered various types of trauma to the abdomen or chest in World War II may develop clinical symptoms leading to the diagnosis. Secondly, the steady increase of the automobile accident rate, unless checked by appropriate safety measures, will assuredly result in a greater number of diaphragmatic ruptures.

Harrington, in a review of his personal cases, found the most common sites of congenital herniations in the order of their frequency of occurrence as: (1) hiatus pleuroperitonealis (Foramen of Bochdalek), the original communication between the pleural and peritoneal cavities; (2) esophageal hiatus; (3) subcostal sternal (Foramen of Morgagni or Larrey's space), between fibers from the ensiform cartilage and adjoining rib cartilages; (4) congenital absence of the posterolateral portion of the diaphragm, that portion derived from the pleuroperitoneal membrane.

Hernias through the vena caval or aortic openings in the diaphragm have never been reported.

The only reliable method of establishing the presence of a diaphragmatic hernia lies in x-ray examination. Photofluoro-

scopic and roentgenographic demonstration of the herniated viscus, with or without the use of contrast media, affords the diagnosis.

The difficulties of an accurate diagnosis are well demonstrated in the case of D. H. M. The importance of repeated examinations cannot be stressed too much. The symptoms are non-specific and share features of many more common pathologic conditions. In general, the symptoms fall into groups corresponding to the organs herniated (usually hollow viscus) and the organs displaced; the severity corresponds closely to the extent of involvement and the degree of hernial ring constriction. Many authors have referred to diaphragmatic hernias as the "masqueraders of the upper abdomen." The onset of difficulty may be acute but is usually noted by its gradual and progressive character.

Physical findings vary widely and are only of limited value. Examination of the thorax might reveal a decreased expansion on the affected side, a displaced apex beat, tympany or dullness depending on the underlying viscera and absent breath sounds.

The most important single factor in making the diagnosis is the inclusion of diaphragmatic hernia as one condition to consider in the differential diagnosis of disease in the chest or upper abdomen. Adams and Lee report two cases with only omentum in the hernial sac which were mistaken for pulmonary lesions until thoracotomy revealed their true identity.

A history of previous injury to the thorax or abdomen is helpful in traumatic herniations.

Operative repair must be considered in the management of all patients with a demonstrable diaphragmatic herniation when either abdominal or cardiorespiratory symptoms are present, with no evidence of other disease as the causative agent. There is some disagreement with this; but considering the proven progressive nature of the condition, the frequent reports of complications (obstruction, strangulation, per-

foration of hollow viscus and hemorrhage) requiring emergency intervention under adverse conditions and the lowered morbidity and mortality arising from recent adjuncts of modern surgery, it seems the better choice. Should surgery be contraindicated or postponed for any reason, a medical regimen must be instituted embodying the following principles: (1) prevention of increased abdominal pressure; (2) prevention of gaseous distention or constipation; (3) impression of the patient with the possible dangers.

No attempt will be made to discuss all of the technical points involved in each type of herniation. The two fundamental principles embody, first, the reduction of the herniated viscera and, second, the repair of the diaphragmatic defect.

A transperitoneal or transpleural approach, for the repair of the average hernia, is largely a matter of personal preference. However, the preferred method depends on the type of hernia to be dealt with in a few selected cases. Closure of the defect with interrupted non-absorbable sutures in two layers is usually adequate. Occasionally a plastic repair with muscle or tendon as outlined by Keller and Saurbruch may be advisable. A combination of the two approaches, thoracolaparotomy, may be required on some occasions.

Various adjunct procedures are occasionally indicated. Phrenic crush or excresis may be utilized to facilitate surgical repair, to minimize recurrence, to obtain relaxation of the hiatal ring in acute obstruction and for relief of symptoms where more radical intervention is contraindicated.

Enterostomy or enteroenterostomy may be necessary as a preliminary life saving procedure or as an adjunct measure in cases of acute obstruction.

Closure of large defects is facilitated by thoracoplasty.

During the preoperative and postoperative periods, the usual measures taken for laparotomy or thoracotomy are carried out. These are adequately illustrated in the accompanying case reports.

CASE REPORTS

CASE 1.   D. H. M., an eighty-three year old retired painter, first entered University Hospital, Columbus, Ohio, on November 27, 1944, complaining of intermittent epigastric pain, severe episodes of nausea and vomiting, palpitation, increasing weakness and weight loss. Epigastric distress, described as heartburn, often amounting to pain, had begun in 1936. The symptoms had no relation to meals; they were relieved by soda. The difficulties were progressive in nature, gradually increasing in severity. Nausea and later regurgitation and vomiting appeared. The bowels became sluggish, finally leading to severe obstinate constipation. In 1942 he consulted his physician who diagnosed the condition as "gallbladder" trouble and prescribed a low fat diet and certain medications, a regimen which the patient followed without relief. In 1943 he had an attack, the features of which were substernal distress, palpitation, increasing weakness and dizziness. During this period the patient noted black, tarry stools. Similar and even more aggravated episodes followed at shortening intervals. These were associated with persistent nausea and recurrent vomiting. His appetite became very poor and weight loss became noticeable. Two weeks before admission an attack similar to the above appeared but showed no signs of abatement; hematemesis began two days before he sought medical advice.

Physical examination showed moderate dehydration and evidence of recent weight loss; the blood pressure was 180/80. Decreased vocal and tactile fremitus was demonstrated in the left chest posteriorly. Coarse moist rales were heard in both lung bases. The heart was enlarged to the left anterior axillary line; a soft blowing systolic murmur was heard over the aortic area. Marked tenderness was elicited by palpation in the mid-epigastric region. The liver margin was palpated three-finger breadths below the right costal margin.

Laboratory findings were as follows: red blood count 3.56 million; hemoglobin 10 Gm. Gastric analysis, utilizing the alcohol test meal, disclosed hypoacidity. Occult blood was found in the first and third gastric specimens. Repeated examinations of the stools revealed 4 plus occult blood. The remainder of the laboratory findings were normal. A chest x-ray disclosed a diffuse density in the left base, 6 cm.

in diameter. Complete roentgenologic studies of the gastrointestinal tract by contrast media failed to demonstrate any pathologic condition except diverticulosis of the entire large bowel. A non-visualizing gallbladder was reported after the usual dose of priodax. Electrocardiography revealed left axis deviation. Digitalization was accomplished. A modified ulcer regimen gave moderate relief of the symptoms. On December 13, 1944, gastroscopy revealed a polypoid, juicy red mass, 1.5 cm. in diameter in the upper one-third of the stomach near the lesser curvature. Superior and anterior to this mass a sharply demarcated, reddish, granular area was seen. The impressions included hypertrophic gastritis, most marked in the cardia; gastric polyp; possible carcinoma of the cardia. Surgical exploration was advised, but the patient refused. He was discharged under the care of the out-patient department on December 16, 1944.

During the following year the patient was seen intermittently at the Gastrointestinal Clinic. He continued to have the same complaints; treatment remained symptomatic. Vomitus, containing considerable bright red blood, was noted on two separate occasions. Tarry stools were noted as before. The interim between the more severe attacks of epigastric pain, nausea and vomiting shortened. In December, 1946, the discomfort became almost unbearable. After each meal he would note a dull ache in the epigastrium; this would increase slowly over one to one and one-half hours to the peak of the pain which was described as severe and knife-like, located 4 cm. above the umbilicus. Radiation into the left hypochondrium and back often occurred. On certain instances he found liquids more of a precipitating factor than heavy foods. The pain and discomfort then gradually declined over the next several hours. Only residual soreness remained during the interims. Nausea accompanied the attacks. Vomiting which frequently occurred at the height of the pain would give rise to temporary relief. On January 2, 1946, he was readmitted to the Medical Service. He complained of extreme weakness and weight loss. All desire for food of any kind was gone. The system review was negative except for nocturnal frequency, times two; slight hesitancy. His past history, other than that described above, was not significant in any particular. He had had typhoid fever at the

age of fifty with no complications. The only history of trauma was a compound fracture of the left wrist incurred as a child. The patient's father and first wife had died of tuberculosis. His "mother" had died of a tumor in her abdomen.

Physical examination revealed a well developed, poorly nourished, eighty-three year old white male, sitting up in bed complaining of severe epigastric distress. He was apprehensive but cooperative. The particulars of the examination were normal except as noted: temperature 98.2; pulse 70; blood pressure 165/86. The skin was dry and wrinkled. Reddish brown macules were observed over the trunk. Tissue turgor was poor. Weight loss was in evidence. The tongue was dry and coated. The lung fields were clear. No inspiratory or expiratory lag was demonstrable. The point of maximum impulse was palpable in the midaxillary line. No murmurs could be heard. The abdomen was moderately distended. Marked tenderness was demonstrated midway between the umbilicus and ensiform. This was associated with spasm and guarding but no true rigidity was present. The liver and spleen were not felt and no masses could be palpated. The prostate was slightly enlarged but of normal consistency. The laboratory findings were normal except for the following: Certain negative findings pertinent to the differential diagnosis are included. Repeated blood studies disclosed a persistent and increasing hypochromic anemia; slight leukocytosis with a marked eosinophilia (varying from 12 to 54 per cent). While receiving a meat free diet, repeated stool specimens contained 4 plus occult blood. Gastric analysis, utilizing the histamine test meal, disclosed below normal values for acid; the third specimen contained 3 plus occult blood. The sedimentation rate (Westergren) was 71-114-130-134. The blood urea nitrogen varied from 41.5 mg. per cent at the time of admission to a normal value of 21 mg. per cent at the time of discharge. The total protein was 7.27 Gm. with an A/G ratio of one. Bence Jones protein was negative in blood and urine; the blood was type A. Electrocardiography revealed minimal evidence of myocardial damage. During the initial four weeks of his hospitalization the patient showed a steady downhill course. He rejected almost all food. Any nourishment taken orally resulted in episodes of severe epigastric pain and vomit-

ing. At one time during this period the possibility of his difficulties being more imaginary than real were considered. Repeated use of sterile hypos resulted in no relief. The psychiatric consultant was of the opinion that the pain was not exaggerated. The patient's weight dropped steadily from 155 to 134 pounds. A deltoid muscle biopsy was reported as revealing no evidence of trichinae by the hospital pathologist. A scout film of the abdomen on January 3, 1946, disclosed no disorder. A six-foot upright chest plate (Fig. 1) revealed a diffuse density of the left lower chest, a condition practically unchanged since November 28, 1944. Repeated attempts to visualize the gallbladder failed. Skull x-rays on February 7, 1946, revealed no evidence of multiple myeloma or other abnormality. Gastrointestinal roentgenograms on January 8, 1946, failed to demonstrate any pathologic disorder.

On February 15th the hospital roentgenologist repeated fluroscopic studies of the upper gastrointestinal tract and reported the following: "The esophagus is slightly shortened. There is a large gastric herniation through the esophageal hiatus which reduced following the drinking of water. The remainder of the stomach and duodenum showed no intrinsic abnormality. Findings indicate an esophageal hiatus hernia." (Fig. 2.) A surgical consultation was sought on the following day. Surgical repair of the demonstrated hiatus hernia was advised via the abdominal route to enable a thorough exploration of the abdomen for concomitant disturbance. Preoperatively, intubation and gastric suction was instituted. Only clear liquids were allowed by mouth. It was notable that continuous Levine suction gave the patient complete relief from pain. A restoration of the fluid and electrolyte balance was accomplished by parenteral administration of fluids, vitamins, plasma and whole blood. A thorough large bowel prep was accomplished by repeated enemas. The patient was kept as ambulatory as possible during this period. A preoperative consultation was obtained with the anesthetic department relative to the premedication and type of anesthesia.

On January 20, 1946, laparotomy was performed by the author under sodium pentothal, nitrous oxide, oxygen anesthesia, with a Magill tube in place, employing an upper left split rectus incision with a hockey stick extension
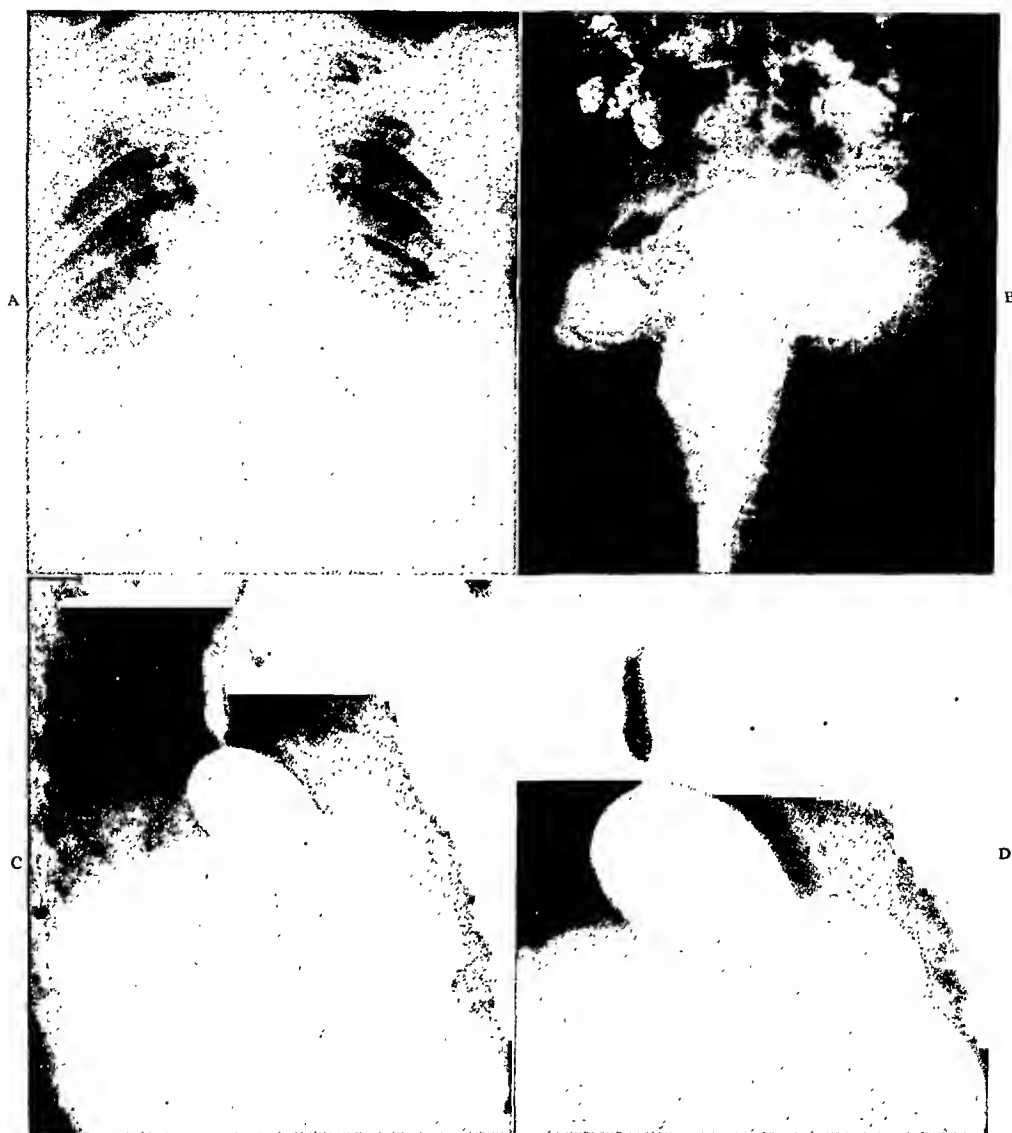
FIG. 1. Case 1. A, roentgenogram of chest showing a diffuse density in the left lower chest; later shown to be an esophageal hiatus herniation with involvement of a large part of the fundic portion of the stomach. From this one can see how easily a lesion of this type could be mistaken for a pulmonary process. B and C, roentgenograms of lower esophagus and upper stomach after ingestion of barium, showing a slightly shortened esophagus and a large gastric herniation through the esophageal hiatus. This reduced following the ingestion of water. D, spot film of herniation as demonstrated on lateral view.

high into the xyphosternal notch. A Balfour retractor was utilized to facilitate exposure. A generalized exploration of the abdomen revealed diverticulosis of the entire large bowel. The esophageal hiatus admitted three fingers on its left lateral aspect. Protruding through this opening was a large portion of the fundic area of the stomach which was easily reducible but which on release of the gentle traction applied, immediately herniated back through the opening. The involved area was markedly hypertrophied. There was no evi-

dence of a callous ulcer, polyp or tumor mass. A moderate amount of serosanguineous fluid was noted in the peritoneal cavity. Exposure was obtained and maintained by walling off the area with large moist laparotomy sponges. The liver, protected with a moist laparotomy sponge, was gently retracted with a broad Deaver retractor. The evaginated hernial sac was opened exposing the margins of the diaphragmatic defect. The lateral extent of the defect was grasped with a long Allis forceps and with the hernial opening under tension, the
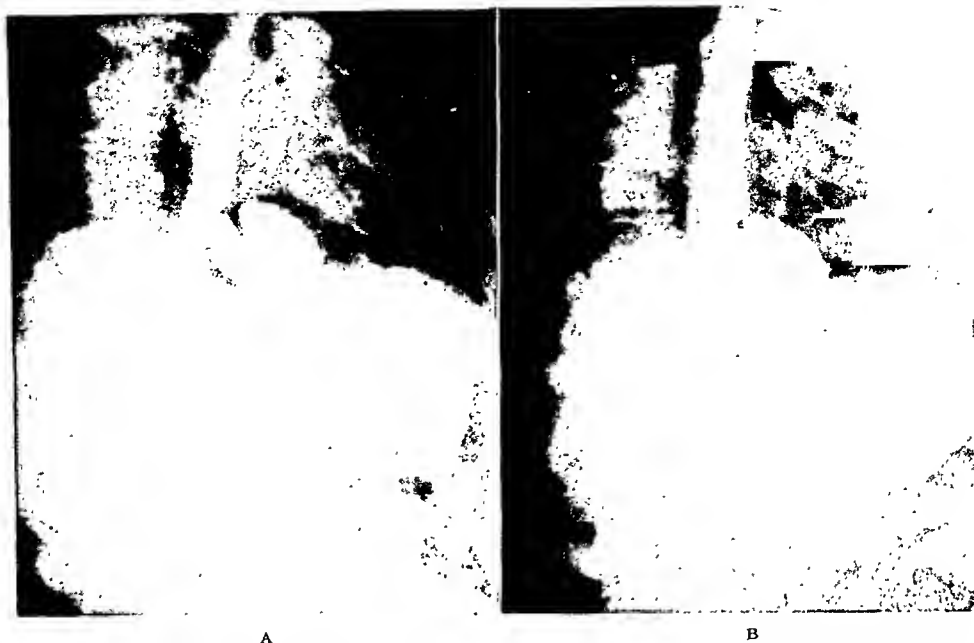
FIG. 2. Case I. A and B, left lateral oblique roentgenograms of lower esophagus and upper stomach after ingestion of barium showing the progressive reduction as seen on fluoroscopy.

edges of the defect were approximated with through-and-through silk sutures. This resulted in an opening just admitting the small finger. The cut edges of the peritoneal sac were then closed with interrupted No. oo silk sutures. Three Gm. of microcrystalline sulfathiazole was dusted over the operative site. The abdominal incision was closed in layers using interrupted figure-of-eight steel alloy wire sutures on the fascia of the anterior rectus sheath; 500 cc. of whole blood was given during the operative procedure. The patient left the operating room with no signs of respiratory difficulty or circulatory failure. Continuous gastric (Wangensteen) suction was employed for forty-eight hours postoperatively, during which time the patient was supported with parenteral fluids. He was allowed out of bed on the first postoperative day. Soft diet was permitted on the third day and a full diet on the fifth. There were no complaints referable to the alimentary tract following the operation. The wound healed per primum. An upper gastrointestinal series on the twelfth postoperative day revealed no evidence of the previously noted esophageal hiatus herniation. The patient was discharged from the hospital on his fourteenth postoperative day.

CASE II. W. D., a thirty-one year old truck driver, was admitted to University Hospital, Columbus, Ohio, on February 4, 1946, with complaints of dyspnea, palpitation, attacks of unconsciousness and difficulty in eating. His difficulties dated back to April, 1935, at which time he had been involved in a serious accident. An eighteen-ton trailer broke loose from its tractor truck, crushing its cab against a large tree. The driver, D. W., pinned between the steering gear, pressing deep into the left side of his abdomen and the driver's seat, was finally removed from the wreckage nine hours later. He suffered a compound fracture of the right ankle and upper one-third of the right tibia, a crushing injury of the right foot, a simple fracture of the left pelvis and deep lacerations of the left chest and neck. The abdominal wall had not been perforated. During his hospital course a ruptured left diaphragm was discovered. Surgical repair had not been advised presumably because of his poor general condition. There had been a 100 pound weight loss during the three-month hospital stay.

In the months following his release he gradually gained weight and strength. The eleven-year interval was described as a veritable nightmare. Epigastric pain and fullness appeared after eating. Associated nausea was severe and aggravating since he found that he was unable to vomit. Belching was difficult, having to turn his head in various ways to allow escape of gas through the esophagus. The discomfort was made worse by alkalies. Dysphagia appeared during the last several

FIG. 3. Case II. Roentgenograms of the chest taken in an anteroposterior position. (A) and left lateral position (B) showing an elevation of the stomach and colon shadows on the left with a resultant compression of the lower portion of the left lung. The remainder of the lung fields were clear.

years. Often he was able to swallow only small sips of liquids. By avoiding gas-producing food and eating frequent small meals, enough nourishment was obtained to retain a nominal state of nutrition. Attacks of dyspnea and cyanosis, leading to unconsciousness had been occurring at more frequent intervals. The "blackouts," usually associated with a period of severe constipation, were relieved by a sudden passage of flatus and stool. Two episodes resembling acute intestinal obstruction were described. The patient was hospitalized in each instance but no operative procedure had been offered to relieve his difficulties. He was of the opinion at the time of admission that life was not worth living if nothing could be done for him. His previous medical history was not significant in any particular. The family history was not pertinent.

Physical examination showed the patient to be a spare adult male, appearing much older than his actual age of thirty-one years. The particulars of the examination were essentially normal except for the chest and right lower extremity. The left intercostal spaces were narrowed. There was a marked lag of respiratory excursion of the left chest wall. A tympanitic percussion note was noted over the left lower thorax, extent varying at different times of examination. Intestinal borborygmi and

a metallic tinkling synchronous with respiration were heard over the left chest. The heart was displaced to the right. The abdomen was scaphoid. Moderate distention was present. Moderate bilateral indirect inguinal hernias were demonstrated. There was a long, irregular, healed scar over the anterior upper aspect of the right leg. The right foot was deformed. Laboratory findings were normal. Posteroanterior and left lateral x-rays revealed an elevation of the stomach and colon shadows on the left. (Fig. 3.) The lower portion of the left lung was compressed. The remainder of the lung fields was clear. Gastrointestinal x-ray series showed the stomach herniated through a rent in the left diaphragm. (Fig. 4.) Barium enema demonstrated the splenic flexure of the colon in the left thoracic cavity. (Fig. 4.) There was no constriction of the large bowel or other abnormality detected. The vital capacity was 2,650 cc. A preoperative consultation was obtained from the Department of Anesthesia regarding preoperative medication and type of anesthesia. The large bowel was thoroughly cleansed with enemas the day before surgery. A Levine tube intubation was accomplished the morning of surgery and all of the gastric contents evacuated.

Thoracotomy was accomplished by the author on February 11, 1946. Prophylactic
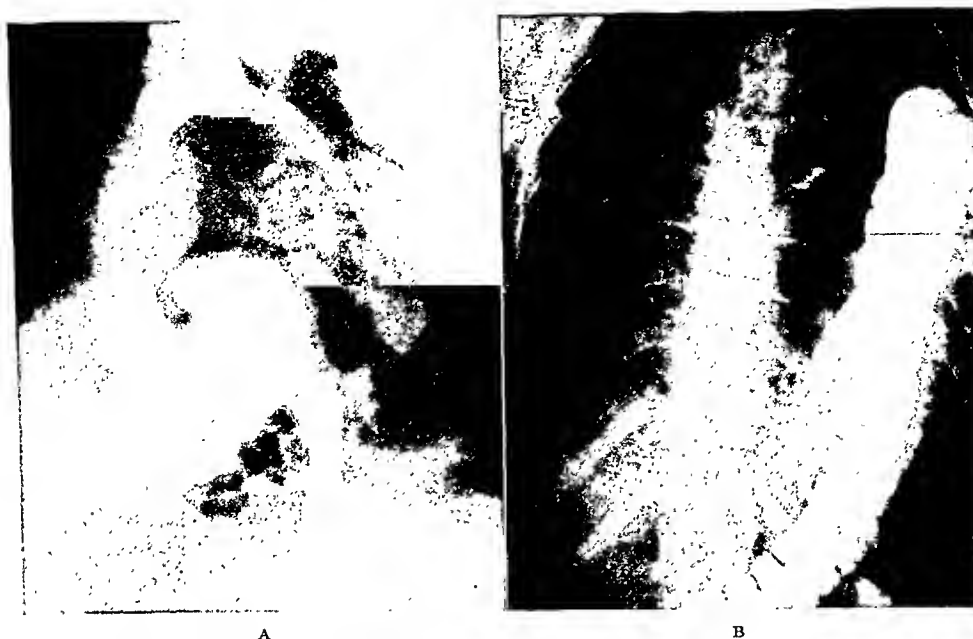
FIG. 4. Case II. A, roentgenogram of the esophagus and stomach after ingestion of barium showing a large portion of the stomach herniated through a rent in the left diaphragm. B, a barium enema demonstrates the splenic flexure of the colon in the left thoracic cavity. No constriction of the large bowel or other abnormality can be detected.

penicillin, 30,000 units every three hours by the intramuscular route, was instituted twenty-four hours before surgery. Following pentothal, cyclopropane induction, a woven catheter endotracheal tube with an inflatable cuff was inserted into the trachea through a laryngoscope. Following inflation of the cuff, the intratracheal tube was connected with a Connell anesthetic machine. A correct level of anesthesia was then maintained by a cyclopropane-oxygen-helium-ether combination. The eighth rib was identified by counting from the palpable twelfth rib previously demonstrated by x-ray. A generous curved incision was made along the eighth rib from 3 cm. lateral to the spinous processes to the anterior axillary line. This was carried through the latissimus dorsi and serratus anterior muscle groups. The serratus posterior muscles were separated from the seventh, eighth and ninth ribs. The peritoneum was stripped away from the eighth rib anteriorly by a periosteal elevator. After freeing the posterior bed with the rib stripper, a generous section of the rib was resected. The neck of the seventh rib was transsected and a 1 cm. segment removed. The pleura was opened in the middle of the rib bed. The hernial opening in the left diaphragm was large, measuring some 6 by 14 cm. It was situated anteriorly about 2 cm. from the diaphragmatic attachments to

the costal cartilages and extended from the tip of the eighth costal cartilage to the parasternal area at the base of the pericardium. It did not involve the esophageal opening. The pleura and peritoneum could not be differentiated by appearance. Lateral and posterior to the left lateral extent of the hernia ring a weakened musculature could be palpated. The lung was compressed upward but was not involved in any adhesions. It expanded normally on application of positive pressure by the anesthetist. The contents and their position were as follows: The stomach was lying posteriorly. The colon skirted the outer wall of the thorax; the spleen occupied an anterolateral position. Three loops of small bowel were seen emerging through the orifice near its center. The left lobe of the liver projected through the most medial extent. The only adhesion demonstrated stretched between the lateral extent of the hernial ring and the left portion of the mesocolon. The omentum hung over most of the contents as a gigantic curtain. The adhesive band was isolated, sectioned between clamps and ligated. The left phrenic nerve was identified on the pericardium and crushed by means of an Ochsner clamp. Following further quieting of the diaphragm and chest wall by means of intravenous curare, the hernial contents were reduced in the following order: small intestine, colon, spleen, stomach, omen-

tum, left lobe of the liver, thus completely replacing the herniated abdominal viscera. The edges of the diaphragm were then freshened; guy sutures were inserted at either end for traction and to facilitate exposure. An abdominal exploration through the hernial opening demonstrated the normal positions and relations of the reduced viscera. The stoma was then closed with through-and-through No. 4 braided silk sutures. Repleuralization was accomplished by interrupted No. oo silk Lembert sutures. Blood clots were removed from the pleural cavity. A stab wound was made in the posterior angle of the ninth interspace, a curved forceps passed through and a Pezzar catheter drainage tube pulled through from inside out. The catheter was clamped shut. The pleural cavity was then closed with interrupted No. oo silk sutures, the lung having been completely re-expanded by application of positive pressure just before the cavity was drawn shut. A previous re-expansion had demonstrated no atelectasis. Muscles, subcutaneous tissue and skin were closed with interrupted sutures of No. oo silk and sterile dressings applied. During the operative procedure 1,000 cc. of whole blood was given by slow intravenous drip.

The patient left the operating room in excellent condition without evidence of respiratory embarrassment or circulatory failure. The Pezzar catheter was attached to a water bottle with the opening 10 cm. below the water level. Drainage was minimal. The catheter was removed on the third postoperative day. Levine suction was maintained for three days during which time the patient was maintained by parenteral injections. The lower bowel was kept empty by use of a rectal tube and repeated small enemas. Penicillin was continued for seven days. A liquid diet was permitted on the third postoperative day, soft diet on the fifth and a full diet on the eighth day. The patient was made ambulatory on the third postoperative day. Healing of the wound was uncomplicated and the patient was discharged from the hospital without complaints eleven days after the operation.

On March 24, 1946, he was readmitted to University Hospital for repair of bilateral indirect inguinal hernias. At this time he had no complaints referable to either the gastrointestinal tract or cardiorespiratory system. He was indeed a truly grateful patient. The thoracotomy wound was well healed. A chest x-ray on March 25, 1946, showed the left diaphragm in normal position and the lung fields clear.

CONCLUSIONS AND SUMMARY

Evidence is cited from the literature and self-experience to support the apparent increased incidence of diaphragmatic hernia. It is suggested that we may be faced with an actual increase in view of the rising accident rate.

The outstanding clinical features are discussed briefly. The progressive nature of the process is pointed out. It is shown that the most important single factor in making the diagnosis is the inclusion of diaphragmatic hernia as one condition in the differential diagnosis of disease in the chest or upper abdomen. The importance of competent radiologic assistance in the diagnosis is emphasized.

Indications relative to medical versus surgical management are discussed. The essential features embodied in conservative medical management are listed. The importance of operative intervention of demonstrable diaphragmatic hernias in those patients presenting gastrointestinal or cardiorespiratory symptoms of any marked degree, with no evidence of other disease, is pointed out.

The preferred approach, transthoracic, transperitoneal or a combination of the two is considered with regard to the type herniation demonstrated. Certain adjunct surgical procedures are evaluated.

Two cases are presented in detail. Case 1 illustrates, first, how few diagnostic problems confronting physicians are more difficult than those presented by patients with a diaphragmatic hernia; second, the value of repeated roentgenography in all suspected cases. Both emphasize the ultimate debility and demoralized mental states resulting from either failure of diagnosis or a hands-off policy. Many of the technical factors involved in the preoperative preparation, anesthesia, the actual repair and postoperative convalescence

are presented. A complete and gratifying relief of symptoms was noted in each patient.

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ABDOMINAL TRAUMA FROM THE STANDPOINT OF THE RAILWAY SURGEON

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I HAVE no startling spectacular new facts to present. I have only some sober, tragic findings to report which I hope may stimulate some interest in a phase of clinical diagnosis and treatment sorely needed for the benefit of patients. It may be that if we heed some of the lessons to be gained from a study of clinical experience and the literature, a few patients may be saved. The saving of one life will more than justify my efforts. My remarks will be limited to the non-perforating or non-penetrating types of abdominal trauma.

The elasticity of the abdominal wall, free mobility of the hollow viscera and comparative mobility of the solid viscera are responsible for the comparative infrequency of lacerations of the spleen, liver, rupture of the intestines and the stomach, following crushing blows applied to the surface of the abdomen.

There are several axioms which should be accepted when dealing with patients who have had trauma to the abdomen: (1) Every patient should be hospitalized for a period of at least twenty-four hours. (2) Every patient should be examined carefully; not only a physical examination but x-ray studies should be made and laboratory data accumulated. The reason for the above statements is obvious when one realizes the infinite variety of combinations of injuries which may occur following the initial blow.

Authorities have classified the etiologic factors in abdominal trauma into: (1) crushing or squeezing, where the patient is impaled between moving objects; (2) from a direct blow from a blunt object and (3) from a fall. To this may be added the classification given by Moty: bursting, crushing and tearing injuries.

The statement that the abdomen, like Pandora's box, is full of surprises is clearly proven by this type of case. Unfortunately symptoms and signs of the true nature of many of these cases are not manifested early.

The literature is full of statements like the following: "The prognosis is directly related to the promptness of surgical intervention" (Wilensky). "During the first few hours after injury no signs nor symptoms may appear. Decision not to operate in many instances is more dangerous than the hazard of an unnecessary operation" (Poer). "There are many cases of abdominal injury on record in which the symptoms at onset are trivial; but, later definite evidence of abdominal lesions requiring operation develop" (Estes). "The time lag between the injury and the definitive treatment must be reduced to as short a time as possible" (Arthur Metz). "Cases of traumatic rupture of the spleen have remained undiagnosed until necropsy" (Roetting). This statement can be easily verified in any large hospital service where cases of trauma are handled.

"Injury due to non-perforating abdominal trauma is accompanied by symptoms which vary to such an extent that no clear clinical picture can be set down" (Poer).

Since the clinical picture is not clear, the signs delayed and the multiplicity of combinations of organs involved, it is incumbent on us to consider each injury as potentially serious until evidence proves to the contrary. It is essential to observe and examine carefully for a few hours in order to determine the need for an operation that will save a life. This is certainly better than to have a patient return to the hospital in an irreversable shock or with peritonitis when surgery, if done as an

antemortem gymnastic, will be of no avail.

From a review of the experiences at Charity Hospital in New Orleans, from personal experiences and from the literature, it is obvious that the spleen is ruptured more frequently than any other abdominal organ following non-penetrating types of trauma. It is obvious that when the spleen alone is involved and when early diagnosis is made and operative intervention resorted to promptly, the prognosis is good. When there are associated injuries, such as fractures of the ribs, perforation or penetration of the lung, ruptures of the liver and rupture of the diaphragm, the prognosis becomes more grave.

Fourteen cases of non-penetrating abdominal trauma reviewed from Charity Hospital records by Dr. Robert Waters present several noteworthy facts. Of the fourteen, nine were found to have the spleen alone ruptured. Five had complications including brain lacerations, fractures of the rib and rupture of the liver. Of the nine uncomplicated cases, splenectomy was done and the patients recovered; the other five patients died. It is worth particular comment as well as commendation that the diagnosis was made and that nine of these patients were saved; and it is a tribute to the training and judgment of the resident staff at Charity Hospital, as I believe all of these cases were handled by the resident staff.

The cause of the accident is stated as having been due to being struck by an automobile, a truck, or a fall from a balcony, struck in the abdomen by a knee while playing ball, struck by a 300 pound block of ice in the left upper quadrant, and a fall in which the patient struck his left side on a garbage can. This case is worthy of further mention. The time of admission varied from thirty minutes to three days.

Abdominal pain, tenderness, some rigidity in the upper left quadrant later becoming diffuse, shock and vomiting were the essential findings recorded by the ob-

servers. X-ray findings are variously reported as negative or as showing an elevation of the leaf of the diaphragm.

The time of operation where stated indicates that the operation was instituted as soon as the patient could be properly prepared and the initial shock overcome by transfusion. The majority of the patients were males.

Since the symptoms and signs by which the diagnosis should be established vary, it may be worth while to review briefly the experiences of others to determine if manifestations not here recorded have been of service in making the diagnosis.

It is easy to make the statement that these patients should be operated upon early. In order to make the diagnosis early two things are essential: First, we must be conscious of the importance of abdominal trauma which is non-penetrating in character and, second, we must seek by observation any and all possible aids in order to determine the necessity for an operation.

Roettig considers the following as diagnostic manifestations: (1) Abdominal pain following injury; (2) progressive shock; (3) rapid thoracic type of respiration; (4) Ballance's sign which may or may not be positive; (Ballance's sign is dullness to percussion in the upper left quadrant and in the left flank) this is commonly found when sought; (5) rigidity of the abdomen which increases with shock and the extent of the injury; (6) the temperature in the beginning is subnormal, pulse is rapid and of poor quality. (7) leukocyte count is usually increased, at first the red count shows slight polycythemia and is followed by a rapid drop; (8) x-ray examination of the abdomen frequently shows an elevation of the left diaphragm.

Lewis T. Wright at Harlem Hospital has had an extensive experience with traumatic rupture of the spleen. He has emphasized the value of an abdominal tap in conjunction with other manifestations. From a review of the literature it does not seem that abdominal tap has been prac-

ticed by most surgeons. My own conviction is that if the other manifestations are present, one had best go ahead and operate; then he can find the blood in the abdomen at the same time. In most cases of rupture of the spleen there is a large quantity of blood in the abdomen and it would seem not an essential procedure to tap the patient before active intervention is undertaken.

It is not only the good results which should impress us but we should look carefully to the cases in which the diagnosis is made at necropsy by the coroner and in which for some reason or other the diagnosis has been missed.

CASE I. A white male, age sixteen, was struck by an automobile. He was not admitted to a hospital for twenty-four hours. At the time of admission lacerations of his scalp and an injury to the right leg were noted. The records indicate that there were no symptoms on admission relative to the abdomen. Six days after admission the patient complained of epigastric pain, slight distention and tenderness, but there was no rigidity in the left upper quadrant. At autopsy a ruptured spleen, a fracture of the skull as well as a fracture of the right fibula were found.

CASE II. A white female, age seventy-nine, fell and struck her left side on a garbage can and was admitted seven hours after the accident. The patient was not in shock at any time. She did complain of tenderness over the ribs on the left side but was discharged from the hospital the next day. She was readmitted three days later with "gastric hemorrhage." There was abdominal tenderness particularly in the upper quadrant. This patient was not operated upon and died sixteen days after the second admission. Autopsy revealed a fracture of the rib, perforation of the pleura, rupture of the spleen and pulmonary emboli. This case illustrates emphatically the importance of not minimizing abdominal trauma.

Surgical Treatment. Splenectomy is indicated. If the mortality is to be low, splenectomy must be done promptly in conjunction with the transfusion of the necessary amount of whole blood. The need for proper replacement has been emphasized time and again, but the need for large amounts of blood and not stipulated quantities, such as 500 cc. or 1,000 cc., should be reiterated. The blood volume should be restored as soon as possible. Pat Imes, in 1947, stated: "A stabilized, blood pressure of 100 millimeters of mercury is highly desirable, and not uncommonly 2,000 to 3,000 cc. of blood are given to obtain it." "Where the response from transfusion is not satisfactory, operative measures are carried out without further delay simultaneously with further blood replacement."

Rupture of the diaphragm following nonpenetrating types of abdominal trauma occurs more frequently on the left side than on the right. If the patient shows evidence of marked shock, dyspnea, cyanosis, rapid-feeble pulse, the x-ray will be of the utmost importance as a diagnostic method. Collapse of the lung and shifting of the mediastinum and its contents to the opposite side with a slight compression of the contralateral lung and an elevation of the dome of the diaphragm call for immediate surgical intervention.

Stewart Harrington, in 1940, stated: "Surgical treatment is demanded because of the danger of cardiac and respiratory failure or because of intestinal strangulation." Delay in this type of case is fatal.

Traumatic Rupture of the Liver. If one is to take the literature as a guide, rupture of the liver is not as uncommon as is sometimes thought.

As early as 1928, B. M. Vance reported from the Medical Examiner's office of New York City and the Surgical Division of Bellevue Hospital, and the Surgical Service of the Presbyterian Hospital: "Of all the abdominal viscera, the liver is the most commonly ruptured by non-penetrating blunt force." This observation is of importance because of the source. Whether it has been confirmed by later reports from the Medical Examiner's office of New York, I have no record.

Reviewing the records Dr Vance stated: "Different degrees of shock were noted:

In a few instances the patient was unconscious and in severe collapse. In others the immediate effects of the injury were not alarming. Four of the patients were able to walk a greater or less distance. Signs of abdominal hemorrhage were frequently present. Rigidity and pain in the abdomen, especially in the region of the liver were noted in all of the cases, except those in which marked shock was present. Pain was referred to the right shoulder in a few cases. External indications of the injury in the region of the liver were evident in only four instances. Pain was aggravated by respiration in some."

O'Callaghan, reporting from St Bartholomew's Hospital in London (1943), noted several interesting facts: "(1) Persistent local rigidity tending to extend and (2) gradual rising pulse rate. Both of these seem reliable in that they do not occur in cases of purely parietal damage. (3) Absolute silence on auscultation may be useful as an indication of peritoneal irritation. This may not occur until several hours after the accident. (4) Release tenderness has been a most valuable sign of peritoneal irritation. It has never been present in a case of purely parietal trauma." O'Callaghan does not attempt to explain why "withdrawal of the palpating hand after firm pressure on the abdomen should so constantly, in cases of peritoneal irritation cause more pain than previous pressure."

In the cases collected at Charity Hospital for me by Dr Robert Waters, there were five in which there was a history of involvement of the liver; the results in these cases were not as happy as in rupture of the spleen. All of the patients were in severe shock on admission and all had multiple injuries. All expired in a very short time; only one is reported to have been operated upon and this patient expired on the operating table. He had rupture of the spleen and of the kidney in association with the rupture of the liver.

Most authors are in accord that there are no pathognomonic signs of this condition. One very accurately states: "The signs of rupture of the liver without penetrating wound are simply those of hemorrhage, shock, and peritoneal and diphragmatic irritation" (Wright).

Rupture of the Intestines. Rupture of the intestines due to non-penetrating abdominal trauma has been observed over a long period of time. As early as 1873, Longuet concluded "that crushing of an intestinal loop between the offending force and the vertebral column or pelvis was the most important mechanism involved." Moty in 1890 classified three types by which traumatic intestinal rupture occurred and these according to Wilensky are still followed today. Moty differentiated between ruptures produced by bursting, crushing and tearing.

Haim in 1910, by comparing the intestines to a football which is composed of an inner rubber bladder and an outer tough leather coat, offered a concept of the mechanism by which such ruptures could occur. "If the bladder is completely invested by the leather coat, the bladder will not rupture unless great pressure is brought to bear upon it. If, however, there is a defect in the leather coat at one point, pressure applied anywhere to the football would result in increasing intra-bladder pressure, with prolapse of the bladder wall at the point of the parietal weakness and eventual rupture at this point."

Wilensky in discussing this states: "If then we consider the internal ring and the various hiatus's as weak points in the outer layer of the endo-visceral cavity, we can understand how increased intervisceral pressure could result in intestinal rupture at one of these points." He states further that "there is a high incidence of hernia in the series in which there has been a rupture of the intestines following non-penetrating types of trauma."

This is a very important factor for consideration by railway surgeons or other surgeons who have to do with surgery of trauma. It is another good reason why industrial organizations should be careful in the selection of their employees and why

they should insist, as I believe most of them do, that patients who have various types of hernia are not good risks for employment in heavy work. If sudden trauma to the abdomen in a patient who has a hernia produces intense pain followed by shock, nausea and vomiting, the patient is a candidate for suspicion of possibile traumatic rupture of the intestines. In some cases it is recorded that the victims were able to walk after a time as symptoms may ameliorate; abdominal tenderness and rigidity are noted later. The x-ray at this time may, and probably will, demonstrate gas under the diaphragm. If these patients are not operated upon following recovery from the initial shock, they will eventually die of peritonitis. It is only during the early stages that an appreciable number of these patients can be saved.

CONCLUSIONS

1. The urgent need for considering every patient who has had severe abdominal trauma as having a potential serious intra-abdominal lesion, such as a rupture of the spleen, liver, diaphragm or intestines must be accepted as a fact.

2. Only by careful examination, hospitalization and early evaluation of the symptoms and signs present can the mortality and morbidity of this type of case be reduced.

3. In these cases there is no substitute for surgical judgment based on experience and well executed technical operative procedures for the welfare of the patient.

4. Proper attention must be given to adequate preoperative and postoperative treatment.

5. Blood replacement must be adequate in quantity and not in specific amounts.

6. The x-ray and laboratory data should be used as consultative aids for early diagnosis.

7. Only by being conscious of the possibilities in these cases can we reduce the mortality from these abdominal traumas.

CLINICAL EXPERIENCES WITH CHLOROPHYLL PREPARATIONS

WITH PARTICULAR REFERENCE TO CHRONIC OSTEOMYELITIS AND CHRONIC ULCERS

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THE search for an *ideal* healing agent in infected granulomatous lesions has been pursued since the days of Hippocrates. That such a search has been fruitless is evidenced by literally hundreds of new "healing" agents tried through the centuries and by the voluminous literature published each year relative to experimental and clinical investigation of such new agents.

An ideal chemotherapeutic agent for wound healing must be one that acts as an antagonist to the bacterial flora present and at the same time acts as a protagonist to the local tissue cells. The leaves and green parts of plants and flowers have been used for generations as adjuncts to wound healing. It was inevitable that chlorophyll, the chemical fraction of the green leaves responsible for such healing properties, would be discovered and isolated sooner or later.

Verdeil in 1851 first pointed out the close chemical structural similarity of hemoglobin and chlorophyll in which the magnesium radical in chlorophyll is substituted by one of iron in hemoglobin. It remained for Willstaetter to be the first in 1911 to evaluate experimentally the cellular stimulant effects of chlorophyll. Since that time exhaustive studies have been made on chlorophyll and its derivatives to evaluate their therapeutic effectiveness. No attempt will be made in this report to review the voluminous literature relative to the experimental and clinical studies of chlorophyll preparations. Over 100 such references are available in domestic and foreign literature for the interested reader.

The action of chlorophyll as a therapeutic agent is essentially that of a stimulant to cellular metabolism. The antibacterial activity of chlorophyll has been evaluated in many experimental studies. Chlorophyll is bactericidal *in vitro* in large concentrations. Clinically it has been reported as especially effective against anaerobic infections in chronic granulomatous processes. The modus operandi of chlorophyll as an antibacterial agent is principally by its stimulating action on the tissue cells rather than as a direct bactericidal agent.

Because of disappointments and failures to obtain early healing in chronic granulomatous processes by the usual classical procedures, and with an increasing number of enthusiastic reports relative to chlorophyll preparations, in recent literature, the writer was stimulated to investigate these preparations clinically in a carefully selected and controlled series of cases. It was believed that such an investigation would be of more definite value if *visual evidence* was used to substantiate the *clinical impressions* of such an investigation. The cases chosen for this investigation were carefully selected from a busy orthopedic service in a prominent teaching hospital. Facilities were available for adequate bacteriologic studies, close clinical observation throughout the course of treatment and adequate follow-up of each case in the Out-Patient Dispensary. The cases selected were in each instance chosen by the writer and followed personally throughout their course of treatment and follow-up. Selected "before and after" color photographs of

* From the Department of Orthopedic Surgery, Medical College of Virginia Hospital, Richmond, Va.

many of these cases were made and their incorporation in this report is offered to the reader in lieu of voluminous statistics and percentages.

The period covered in this clinical study was nine months; 127 cases were selected and treated during this period. The cases selected were as follows: (1) chronic suppurative osteomyelitis, seventy-four; (2) subacute or chronic suppurative osteomyelitis secondary to compound fractures, twenty-five; (3) chronically infected granulomatous wounds, decubitis ulcers, etc., twenty-two; (4) varicose ulcers, six.

The chlorophyll preparations* used were: (1) water soluble active chlorophyll derivatives in isotonic solution; (2) water soluble chlorophyll derivatives in a hydrophylic ointment base; (3) chlorophyll-penicillin solution containing 2,000 units of penicillin per cc. of water soluble chlorophyll derivatives; (4) fine mesh gauze impregnated with water soluble chlorophyll derivative ointment.

METHOD

In the cases of chronic osteomyelitis not associated with compound fractures a thorough sequestrectomy was done followed by the instillation of chlorophyll-penicillin solution into the involved area of bone by means of indwelling catheters. In those cases involving the humerus, tibia or femur adequate fenestration of the bone was done and the indwelling catheters placed directly in the medullary cavity. In every case the surgical wound was packed loosely with fine mesh gauze, with no attempt made to close the wound. Delayed primary closure of the wound was done in five to eight days. The dosage of chlorophyll-penicillin solution was dependent upon the size of the wound, but in most instances consisted of 10 cc. of solution into each catheter three times daily. In every

* The water soluble chlorophyll derivative preparations used in this study were generously supplied by Rystan Company, Inc., Mt. Vernon, N. Y., and are marketed commercially under the trade name "Chloresium."

instance the selected case had been given penicillin parenterally prior to its selection for inclusion in this series. Many of the patients had undergone previous surgery and had received penicillin locally for the osteomyelitis present. A great majority of patients in this group were selected for this study because they had been resistant to previous types of therapy. Bacteriologic studies were made prior to start of treatment and at the time of delayed primary closure. Of the seventy-four cases in this group of infections fifty-nine received the above regimen of treatment. The remaining fifteen cases, involving the small bones of the extremities principally were not subjected to surgical sequestrectomy but were treated locally by daily applications of plain chlorophyll ointment directly to the granulomatous process.

In each of the fifty-nine cases in which surgical intervention was held necessary, delayed primary closure was done in five to eight days at which time the indwelling catheters were removed and the wound closed in layers. Of these cases fifty-six healed per primum following the delayed closure and have remained healed without evidence of recurrence of infection or breakdown of the wound. One patient developed several small subcutaneous abscesses following the delayed closure, necessitating incision and drainage of the abscesses. Two wounds failed to heal following the delayed closure and continued to drain. It is interesting to note that the three cases in which healing failed and which are classed as definite failures in this group contained Pseudomonas aerogenes in the bacterial flora.

The writer by no means wishes to imply that these water soluble chlorophyll preparations, with or without penicillin, offers a therapeutic cure for chronic osteomyelitis; but it is of definite interest, in view of past experiences with long draining chronic osteomyelitic wounds, to see such rapid erradication of infection and healing of wounds in this very distressing disease.

The group of twenty-five cases of sub-
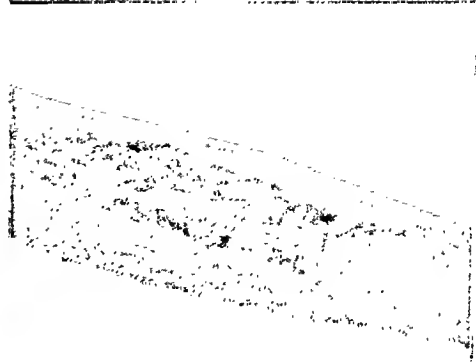
A   B

FIG. 1. A, chronic osteomyelitis of left tibia of four years' duration. There were numerous small draining sinuses with a foul odor. Photograph shows appearance two months after excision of old scar tissue. The lesions were still draining. B, treatment with chloresium effected this improvement in two weeks. All drainage had ceased and there was no odor. Skin progressed to complete epithelialization in twenty-one days. There has been no recurrence.

A   B

FIG. 2. A, ulcer of lower leg of two years' duration. This condition had been treated previously with various ointments and other agents and two unsuccessful attempts at skin grafting. B, treatment with chloresium resulted in this improvement within seven days. The clean epithelial base shown here healed completely with continued chloresium therapy in two and one-half months.

A   B

FIG. 3. A, grossly infected amputation stump with persistent, foul-smelling discharge in a thirty-three year old female paraplegic following disarticulation of the hip. B, daily instillation of chloresium solution (plain) for seventeen days produced this clean, healthy granulating base. No odor or drainage were present. The area was ready for split-thickness graft.
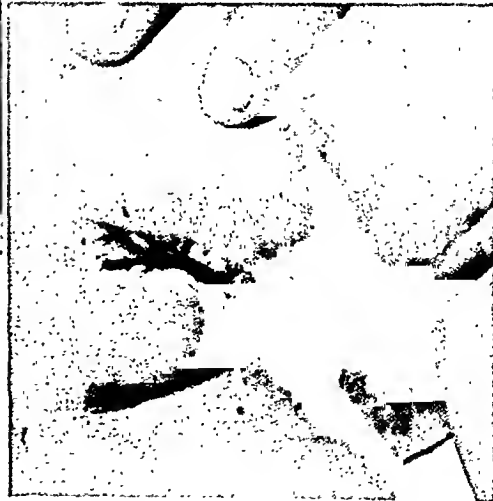
A   B

FIG. 4. A, decubitus ulcer of six months' duration on left buttock of paraplegic. Illustration shows appearance after second attempt at surgical closure with dirty, foul-smelling, sloughing ulcer base. B, treatment with chloresium, the natural, non-toxic chlorophyll preparations, resulted in complete healing of the ulcer in twenty-one days. There was no recurrence after six months.
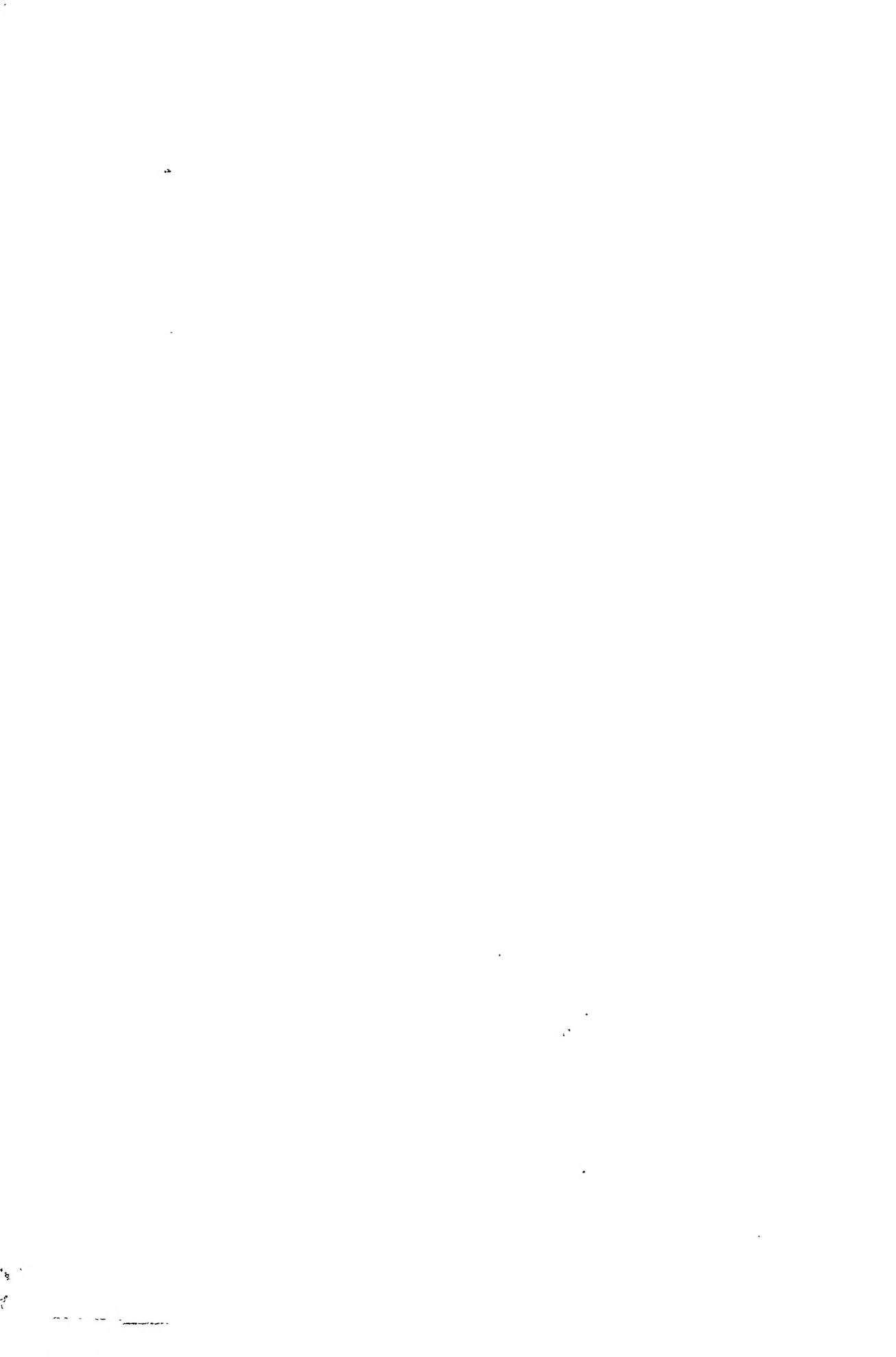
acute or chronic osteomyelitis secondary to compound fractures produced some very interesting results. In every instance the wounds were grossly infected, foul-smelling and in many instances large skin defects were present. At the beginning of treatment plain chlorophyll solution without penicillin was applied directly to the wound in the form of continuous wet dressings. Following diminution of the gross infection present, sequestrectomy was done through windows in the respective casts followed by postoperative instillation of the chlorophyll-penicillin solution into the involved area of bone. At periods varying from seven to twenty-one days split thickness or pedicle full thickness skin grafts were applied to the skin defects present. Fine mesh gauze impregnated with chlorophyll ointment was used as a direct dressing over the skin graft. Plaster immobilization was, of course, maintained in every instance.

Of this group of twenty-five cases skin defects were covered and the wounds healed in twenty-three instances. The other wounds broke down following skin grafting and required additional skin grafting or plastic closures. Follow-up has been obtained on the twenty-three cases which healed and in no instance has breakdown of the wound occurred. The longest follow-up has been only nine months; and while no definite conclusions can be reached with such a short period of observation, it is definitely believed that the period of morbidity has been greatly lessened and early eradication of infection obtained. Following the start of chlorophyll dressings, the rapid disappearance of foul odors associated with these cases was very marked in every instance and was most gratifying to both the patient and to others on the wards. Many of the cases in this group were selected because of their resistance to all previous types of therapy. All had received penicillin and/or sulfonamide medication prior to selection for inclusion in this series.

The group of chronic granulomatous lesions not associated with underlying bony infection consisted principally of decubitus ulcers. Nine such ulcers were on paraplegic patients and the results here were most gratifying. Early erradication of gross infection, early appearance of healthy granulations and progressive epithelization of these decubiti were marked in every instance. Every patient selected in this group had been treated previously with various local ointments and solutions with uniformly poor results. Previous plastic closures had been attempted in three instances, with subsequent breakdown of the lesion. Of the total group of twenty-two cases failure to obtain healing occurred in six instances. It is of further interest that in every case of failure in this group the bacterial flora consisted primarily of Pseudomonas aerogenes. It was noted particularly by the writer that during the entire period of this study the wounds which were resistant or slow to heal contained Pseudomonas aerogenes. Streptomycin in conjunction with chlorophyll solution has been tried on such cases recently and more encouraging results have been obtained.

At the beginning of treatment of these decubitus ulcers plain chlorophyll solution was applied directly to the ulcer in the form of a continuous wet dressing. As soon as the gross infection had subsided chlorophyll ointment was applied daily to the ulcers. It was found that a thick layer of ointment, approximately $\frac{1}{4}$ inch thick, produced more rapid healing than if a thin layer were used. It is well to point out that local treatment of these ulcers must be supported with emphasis on the general nutrition of the patient, particularily to keeping a positive nitrogen balance and replacement of depleted proteins, hemoglobin, etc.

Through the cooperation of the Vascular Clinic of this hospital the author was permitted to select six cases of varicose ulcers for treatment with chlorophyll ointment. Rather than select a large number of cases in this group it was believed that selection

of a few cases which were of long-standing and which had been particularly resistant to all other types of treatment would be more informative. Each case chosen was of several years' duration. The method of treatment consisted of cleansing the ulcer and surrounding skin with ethyl ether followed by application of a thick coating of chlorophyll ointment directly over the ulcer. Gauze sponges were applied over this and a pressure dressing, utilizing either an elastic or Tensoplast bandage. This treatment was given at weekly intervals. This interval between treatments is admittedly long; but because of difficulties encountered in getting the clinic patients to report at shorter intervals, this seven-day lapse between treatments was necessary.

In this group of six cases diminution in the size of the ulcer occurred in every instance within two weeks and complete epithelization was obtained in four instances. An index of the effectiveness of chlorophyll in the treatment of varicose ulcers was evidenced by the increasing number of requests from other clinic patients that they be given the "green ointment" treatment, as they could readily observe the improvement in the patients receiving chlorophyll ointment dressings. The number of cases is small and the period of follow-up is admittedly short, but it cannot be denied that in each case selected very definite improvement occurred with chlorophyll ointment in which previously the ulcers had been resistant to all types of treatment. It is not to be assumed by the reader that chlorophyll is the final answer in the treatment of varicose ulcers or that its use should supplant the general principles of therapy of varicosities. It is believed, however, that as an adjunct to treatment of these ulcers chlorophyll is of very definite value.

The accompanying color photographs (Figs. 1 to 4) with their descriptive captions are offered as the best evidence of the therapeutic qualities of chlorophyll preparations. The writer had no clinical experiences with these preparations prior to the start of this study. An honest attempt has been made to evaluate these water soluble chlorophyll derivative preparations solely on their ability to decrease infection and stimulate healing in chronic granulomatous processes. The number of cases selected in each group is admittedly small and the period of follow-up at the present time is obviously too short to draw any definite or lasting conclusions. The cases of chronic osteomyelitis will have to be followed for long periods as will the cases of infected compound fractures. However, the rapid response to treatment in the great majority of cases in all groups is definite evidence that these particular chlorophyll products do occupy a very prominent place in the realm of stimulants to wound healing.

SUMMARY AND CONCLUSIONS

1. A clinical study of chlorophyll derivative preparations was undertaken to evaluate the effectiveness of these preparations in the treatment of chronic osteomyelitis and chronic ulcers.

2. In the treatment of chronic suppurative osteomyelitis, both of hematogenous origin and secondary to compound fractures, the efficacy of chlorophyll solution locally combined with adequate sequestrectomy, produced uniformily rapid erradication of infection, early wound healing and substantial evidence of clinical cures, not previously experienced in this type of infection when treated by the usual time-honored methods of sequestration followed by prolonged granulation and epithelization.

3. Chlorophyll derivative preparations in the treatment of decubitus ulcers, particularily in paraplegics, demonstrated tissue-stimulating properties, with subsequent early epithelization not previously seen in these particularily slow and indolent types of ulcer.

4. Chlorophyll ointment locally as an adjunct to treatment of varicose ulcers, previously resistant to all forms of treatment, demonstrated remarkable therapeutic properties in every instance.

·5. Color photographs of "before and after" treatment with chlorophyll derivative preparations are offered to the reader as an index of the therapeutic effectiveness of chlorophyll preparations in the treatment of chronic granulomatous processes.

Inasmuch as approximately ten months have elapsed since the main body of this report was prepared the following additional information is added to bring the report up-to-date. The period of follow-up has not been less than eighteen months for any case and on a number of cases two years of observation have been possible.

In the group of patients with chronic suppurative osteomyelitis, of whom fifty-four originally healed following sequestrectomy and delayed primary closure, two have developed recurrence of infection requiring additional surgery. In both of these there was x-ray and operative evidence of further bony destruction and sequestration in the area of bone previously involved. One additional patient had a local recurrence of infection, without x-ray evidence of sequestration. This infection subsided with bed rest, immobilization, general supportive therapy and penicillin parenterally. The remaining patients have been clinically asymptomatic with no evidence of recurrence of infection.

The group of cases of osteomyelitis following compound fractures has been very interesting to observe. Of this original group of twenty-four patients, additional surgery has been necessary in six. This surgery has consisted of bone grafts for non-union or skin grafts for plastic revision of scars. Of the entire group of eighteen patients who have not required additional surgery there has been no evidence of recurrence of infection. Fourteen of these fractures have progressed to bony union. The four remaining are still under treatment for delayed bony union and all show promise of progressing to bony union without additional surgery. Of the six patients requiring additional surgery, one developed a moderately severe postoperative infection following an onlay tibial graft. Whether this infection was a flare-up of a quiescent infection still present at the operative site or was a result of new infection introduced at the time of bone grafting is impossible to say. The group of indolent ulcers or decubiti,

particularily those on paraplegics, have remained healed without evidence of breakdown. Additional cases of paraplegia with sacral or iliac decubiti have responded very nicely to the treatment outlined for such ulcers in the main body of this report. It cannot be emphasized too strongly that the treatment of such lesions must entail rigid adherence to general supportive measures in addition to treatment of the local lesion. The cases of varicose ulcers have unfortunately not been followed as closely as the other groups of cases. Observation on three of the most resistant cases has been possible and to date the ulcers have remained healed without breakdown in two of these cases. The remaining case had a 2 cm. area of breakdown which respond rapidly to chlorophyll ointment pressure dressings, with subsequent healing.

In the main body of this report the fifteen cases of chronic suppurative osteomyelitis of the small bones of the extremities, which were not subjected to sequestrectomy, were not evaluated as to end results due to an oversight. These patients were treated by wet dressings of chlorophyll solution with penicillin locally, followed by local applications of chlorophyll ointment. All of these wounds progressed to eventual healing without surgical intervention. Follow-up has been obtained on twelve of these cases and there has been no recurrence of infection to date. The fate of the other three patients is unknown.

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STRANGULATED FEMORAL HERNIA: RELATIONSHIP OF CONTENTS OF HERNIAL SAC TO CLINICAL MANIFESTATIONS AND PROGNOSIS

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ACUTE strangulation of a femoral hernia has been recognized generally as a surgical condition in which the fatality rate is very high.[6] For many years all efforts to improve this situation have achieved only minor success. The hazard associated with this surgical disease is reflected in the high fatality rate which may be attributed to many factors. Perhaps one of the most significant and often overlooked factors that affects the prognosis is the contents of the femoral hernial sac. When the pathologic condition of the abdominal or pelvic viscera strangulated within the hernial sac is given ample consideration and evaluation, it is seen that the fatality rates recorded among members of the various age groups are surprisingly comparable.

The relatively high frequency with which portions of the small intestine and omentum are found strangulated and obstructed in the femoral hernial sac has been acknowledged by surgeons for many years. The associated high fatality rate often has been attributed to the advanced age and poor clinical condition of the patients,[5] without giving the proper amount of attention to the responsible factor: the pathologic condition of the viscera strangulated in the hernial sac.

In addition to portions of the small intestine and omentum parts of many other structures have been reported as occupying femoral hernial sacs.[3] Some of these structures are the colon, cecum, appendix, sigmoid, bladder, ovary, fallopian tube, uterus, gallbladder, kidney, testicle, stomach and liver. However, many of these organs have been in simple or incarcerated femoral hernias whereas the present report is concerned with the contents of the sac in strangulated femoral hernias.

A comprehensive study of 104 cases in which strangulated femoral hernia was treated surgically at the Mayo Clinic from 1907 to 1946 has been completed recently by one of us (J. P. J.). Certain observations and conclusions derived from this investigative work will be reviewed and discussed in this report.

GENERAL CONSIDERATIONS

It was observed that contents of the sacs of strangulated femoral hernias have a definite relationship to the high fatality rate. Although the advanced age of a patient increases the surgical risk of any operative procedure, it was noted that regardless of a patient's age the pathologic state of certain strangulated viscera, when evaluated at operation, had a more profound effect on the end results than did any other factor.

The purposes of this essay are to report on the contents of the sac found in 104 cases of strangulated femoral hernia and to report the pathologic condition of the strangulated viscera as related to the clinical manifestations, prognosis and fatality rate. Results of this study have indicated that a significant relationship does exist between the gross fatality rate and the pathologic condition of the viscera strangulated in the femoral hernial sacs and that the patient's age is of minor importance.

ANATOMIC CONSIDERATIONS IN FEMORAL HERNIA

Anatomic structures affected by strangulation are the coverings of the femoral hernia, the hernial sac and its contents. The femoral ring is the site of strangulation

TABLE I

STRANGULATED FEMORAL HERNIA: RELATIONSHIP OF CONTENTS OF HERNIAL SAC TO HOSPITAL FATALITY RATE

Contents, Hernial Sac	No. Cases	Deaths in Hospital	
		No.	Per Cent
Small intestine................	64	23	36.0
Viscera other than small intestine	40	1	2.5
Totals.....................	104	24	23.1

in femoral hernias because its rigid walls are formed by Poupart's, Gimbernat's and Cooper's ligaments. These ligaments form a fibrous aperture which is very tenacious when any abdominal or pelvic viscus protrudes into it.

A femoral herniary process courses downward under Poupart's ligament through the femoral ring, separating the femoral vein laterally from Gimbernat's ligament medially to enter the short femoral canal. Then the process protrudes through the fossa ovalis and lodges beneath the superficial fascia of the thigh. The hernial sac is formed from the parietal peritoneum, preperitoneal adipose tissue and transversalis fascia (from the femoral sheath). The hernia sac is usually small and globular but these two factors of size and shape depend upon the volume of the sac's contents.

In the 104 cases of strangulated femoral hernia reviewed by one of us (J. P. J.) there were twenty-four deaths (a fatality rate of 23.1 per cent). It was observed that the viscera most often incarcerated in strangulated femoral hernias were portions of small intestine and omentum and that the pathologic condition of these structures had a direct and influential effect on the

prognosis. This intimate association will be demonstrated in the accompanying tables.

On the basis of the data in Table 1 the high fatality rate might be attributed to the harmful effects on the small intestine caused by strangulation. Our personal observations tend to substantiate this assumption.

When a segment or loop of the small intestine becomes constricted within the femoral ring, the effect on the patient is pronounced because a strangulating type of acute intestinal obstruction is caused. This is a grave situation regardless of the patient's age or general clinical condition. In elderly patients who have acute strangulation pathologic degeneration in the constricted segment apparently progresses rapidly and it is then that age assumes a prominent influence. But, generally, among persons of all ages it is the pathologic state of the strangulated portion of intestine, as ascertained at operation, that has the greatest effect on the prognosis.

When movable abdominal or pelvic organs other than a part of the small intestine become lodged in the femoral ring, the threat to the patient's life is considerably lowered until it almost approximates that of comparable surgical emergencies.

CONTENTS OF HERNIAL SAC

In the 104 cases studied the size of the femoral ring varied to such a degree that twenty-one abdominal and pelvic structures had herniated either singly or in combination. (Table II.)

At all operations the site of strangulation was found to be the femoral ring where the sharp edge of Gimbernat's ligament had caused constriction and early necrosis. The hernial sacs had assumed various sizes and shapes to accommodate the strangulated viscera. The contents of the sacs listed in Table II will be considered separately.

Small Intestine. A segment or loop of small bowel was affected in sixty-four

cases of strangulated femoral hernia. In forty cases the segment of small intestine involved was identified specifically as jejunum or ileum but probably the unidentified portions were also segments of ileum. At operation the strangulated segment

TABLE II

STRANGULATED FEMORAL HERNIA: VISCERA IN HERNIAL SAC AND HOSPITAL FATALITY RATE

Contents, Hernial Sac	No. Cases	Deaths in Hospital	
		No.	Per Cent
Ileum only	28	15	53.6
and omentum	7	4	57.1
and epiploic tag of sigmoid	1	0	
and preperitoneal fat	1	0	
Small intestine* only	16	3	18.9
and omentum	7	0	
and sigmoid	1	0	
Jejunum only	3	1	33.3
Omentum only	22	0	
and appendix	3	1	33.3
and bladder	2	0	
and cecum	1	0	
and sigmoid	1	0	
and preperitoneal fat	1	0	
Appendix only	2	0	
and appendiceal abscess	1	0	
Meckel's diverticulum	2	0	
Sigmoid only	2	0	
Epiploic tag of sigmoid	1	0	
Adenomyoma	1	0	
Endometrial hematoma	1	0	
Totals	104	24	23.1

* The strangulated portion was not identified.

of the small intestine exhibited various degrees of congestion, edema, hemorrhagic infarction, necrosis or gangrene. The extent of these pathologic processes depended on the duration of strangulation which ranged from two hours to twelve days.

When the hernial sac was incised, the character of the fluid within the sac was a good indication of the pathologic condition of the strangulated contents. The fluid had been formed as a transudate of serum after venous compression by Gimbernat's ligament and engorgement of all blood vessels. The fluid within the sac was clear and straw-colored in three cases in which early

strangulation of the omentum had occurred. When pathologic processes had been more progressive, the fluid ranged in color from serosanguineous to dark red to black. When the strangulated portion of the small intestine had become gangrenous, the fluid within the sac had a foul, fecal odor.

Intestinal obstruction was complete in forty-eight patients because both ends of the loop of bowel were constricted tightly in the femoral ring in each instance. In sixteen patients partial strangulation (Richter's hernia) had taken place in which a portion of the circumference of the bowel along the antimesenteric border was constricted within the femoral ring but the lumen of the bowel was not completely occluded.

The strangulated segment of the small intestine had become gangrenous in twenty-six patients; primary resection of the ileum had been performed in sixteen patients with ten deaths. In those cases of gangrenous small bowel the duration of strangulation had ranged from two hours to eight days with a mean of two and a half days.

Microscopic examination of the preserved surgical specimens showed that the length of the strangulated loop of bowel had ranged from 6 to 45 cm. Perforation of the bowel had occurred at the constricting site in five specimens and at the center of the necrotic loop in four others. A definite constriction ring had persisted in ten specimens, three of which were Richter hernias of the ileum. Microscopic examination revealed extensive hemorrhagic infarction and necrotic changes in the strangulated portions of all specimens.

In the group of twenty-six cases in which the strangulated segment of small intestine was gangrenous there were nineteen deaths (a fatality rate of 73.1 per cent). The distribution of these twenty-six patients according to age is presented in Table III.

In Table III the most striking observation is the very high fatality rate associated with the presence of a gangrenous portion

of small intestine in the hernial sac; the influence of the age of a patient seems less marked. Thus, as said previously, it would appear that the pathologic condition of the strangulated viscus when determined at operation has a more profound effect on the prognosis than does the patient's age alone.

TABLE III
STRANGULATED FEMORAL HERNIA: AGES AND FATALITY RATES: TWENTY-SIX PATIENTS WITH HERNIAL SAC CONTAINING GANGRENOUS SEGMENT OF SMALL INTESTINE

Age, Years	No. Patients	Deaths in Hospital	
		No.	Per Cent
30–39	1	1	100.0
40–49	3	2	66.7
50–59	5	2	40.0
60–69	9	8	88.9
70–79	8	6	75.0
Totals	26	19	73.1

In the other thirty-eight cases of the sixty-four in which the small intestine was involved in the hernia the strangulated portion of small intestine was described by the surgeons as congested, edematous, discolored or cyanotic but the portion of intestine concerned was viable and non-gangrenous. The average duration of strangulation was one and a half days. The distribution of these thirty-eight patients according to age is reviewed in Table IV.

When the fatality rate of 73.1 per cent (Table III) and that of 10.5 per cent (Table IV) are compared, it is obvious that a favorable prognosis in cases of strangulated femoral hernia depends on early surgical treatment before necrosis of the contents of the hernial sac has taken place.

That the contents of the hernial sac rather than the patient's age have a more pronounced and direct effect on the prognosis is exemplified again in Table V. When those patients in whom portions of the small intestine were incarcerated are excluded, forty patients remain in whom

other abdominal or pelvic viscera had strangulated in the femoral hernial sacs.

The strangulated structures referred to in Table V were portions of omentum, urinary bladder, sigmoid, epiploic tag of sigmoid, cecum, appendix, Meckel's diverticulum, adenomyoma, preperitoneal adipose tissue and an endometrial hema-

TABLE IV
STRANGULATED FEMORAL HERNIA: AGES AND FATALITY RATES: THIRTY-EIGHT PATIENTS WITH HERNIAL SAC CONTAINING VIABLE AND NON-GANGRENOUS PORTIONS OF SMALL INTESTINE

Age, Years	No. Patients	Deaths in Hospital	
		No.	Per Cent
30–39	3	0	
40–49	7	1	14.3
50–59	8	0	
60–69	11	1	9.0
70–79	9	2	22.3
Totals	38	4	10.5

toma. The fatality rate (2.5 per cent) in this group is comparable to or lower than the fatality rates associated with many formidable surgical diseases.

Omentum. Portions of the omentum were strangulated in the hernial sacs either singularly or in combination with other viscera in thirty-eight patients. When por-

TABLE V
STRANGULATED FEMORAL HERNIA: AGES AND FATALITY RATES: FORTY PATIENTS WITH HERNIAL SAC CONTAINING STRUCTURES OTHER THAN PORTIONS OF SMALL INTESTINE

Age	No. Patients	Deaths in Hospital	
		No.	Per Cent
5 mo.	1	0	
30–39 yr.	3	0	
40–49 yr.	5	1	20
50–59 yr.	14	0	
60–69 yr.	11	0	
70–79 yr.	5	0	
80–89 yr.	1	0	
Totals	40	1	2.5

tions of omentum and small intestine had been strangulated together, the omentum was damaged more severely than the bowel which presumably had been protected by the omentum. The affected portion of the omentum was excised when its viability was questioned and there were no complications in this series relative to omental resection.

Urinary Bladder. Portions of omentum and urinary bladder were found in two hernial sacs in which the bladder had been present as a sliding hernial process. In each instance the involved portion of the bladder was viable and easily reduced. In each case, similarly, urinary frequency, tenesmus and dysuria had been noted clinically since the onset of strangulation.

Sigmoid Flexure. Portions of the sigmoid flexure were involved in four left femoral hernias, three times as sliding hernial processes and once as Richter's hernia. Strangulation of the sigmoid flexure had simulated the clinical manifestations of a malignant lesion in causing partial obstruction of the rectosigmoid portion of the intestinal tract. The involved portion of sigmoid was viable in all instances and no sequelae followed reduction.

Appendix. There were six cases of strangulated femoral hernia involving the vermiform appendix in the hernial sac. In four cases the appendix had herniated through the femoral ring and had strangulated. One of these cases was reported by Black and Waugh in 1942.[1]

Gross and microscopic examinations were conducted on three preserved surgical specimens in which the hernial sac and appendix were excised together. The appendices were from 2 to 6 cm. in length within the femoral hernial sac. In two specimens numerous fine adhesions were found between the parietal peritoneal lining of the sacs and the serosa of the appendices. These inflammatory adhesions indicated that the appendices probably had occupied the femoral canal for an indefinite period preceding the onset of acute strangulation.

In two cases a fluctuant mass had appeared previously in the femoral region. In one case this mass, diagnosed as an "inguinal abscess," had been incised and drained by one of us (J. H. P.). The patient, a woman seventy-eight years old, returned four weeks later with clinical evidence of diffuse peritonitis. Laparotomy was performed and the tip of the appendix was found constricted within the femoral ring. It had perforated two times, once into the femoral canal and, more recently, into the abdominal cavity. The appendix was removed and the patient had a satisfactory convalescence.

In the other case the patient was a woman sixty-three years old. A suppurating sinus tract had developed in the right groin after incision and drainage of a fluctuant mass. Abdominal exploration revealed that the tip of the appendix had strangulated in the femoral ring and had perforated into the femoral canal, forming the fluctuant, suppurative mass.

In these two patients in whom a so-called inguinal abscess had been incised and drained previously further surgical exploration possibly would have been justified at that time, and the perforated appendix thus might have been located within the femoral ring. Hence, it would appear that when a fluctuant mass in the femoral region is incised and drained, especially in elderly patients, the possibility of the presence of an appendiceal abscess in a femoral hernial sac should be considered.

In another case involving strangulation of the appendix within the femoral canal acute perforation had occurred at the base of the appendix just proximal to the femoral ring. This patient died of diffuse peritonitis on the tenth postoperative day.

It is highly significant that in each case involving strangulation of the appendix in the femoral sac the classical symptoms and signs of acute appendicitis had been present in addition to a fluctuant, tense mass in the right groin. Pain in the right lower quadrant of the abdomen, occasional chills and slight fever had been among

the symptoms recorded but the correct diagnosis had not been suggested preoperatively.

Meckel's Diverticulum.   In the two cases of Littre's hernia each hernial sac contained a Meckel's diverticulum that had strangulated in the femoral ring. The diverticulum was ligated and the stump was inverted in both cases. One patient has been operated on two times since for acute ileal obstruction.

Adenomyoma.   This tumor was found in a hernial sac of a woman fifty years old who had had a mass in the right femoral region for twenty years. At each menstruation, this mass had been painful and tense. Operation was performed during an acute exacerbation of symptoms and a mass, located in the femoral canal, was diagnosed microscopically as a strangulated adenomyoma.

Endometrial Hematoma.   A five months' old female infant was operated on for a strangulated right femoral hernia. The hernial sac contained a small, firm mass which was diagnosed microscopically as strangulated ectopic endometrial tissue in an organized hematoma.

Comment on Contents of Hernial Sac. The foregoing discussion of the contents of the hernial sac found in 104 strangulated femoral hernias indicates that a definite relationship exists between the origin and pathologic condition of the affected viscera and the hospital fatality rate. When a segment of small intestine has been strangulated, the eventual prognosis can be ascertained fairly accurately during the operation as the extent of damage to the bowel is determined. The prognosis becomes more grave as the pathologic processes progress.

CLINICAL MANIFESTATIONS

A fundamental relationship also exists between the contents of the hernial sac and the clinical manifestations that follow acute strangulation. The clinical symptoms and signs that had been recorded in this series of strangulated femoral hernias were

tabulated in order of appearance and then were classified into three groups according to the pathologic condition of the contents of the sac.

Group 1 comprised twenty-six cases of strangulated and gangrenous portions of small intestine. Group 2 comprised thirty-eight cases of strangulated but viable portions of small intestine. Group 3 comprised forty cases of other strangulated structures.

The significant clinical symptoms and signs that had been noted are summarized diagrammatically in Figure 1. Each symptom or sign has been tabulated as a percentage relative to its appearance in the respective group.

Onset.   In ninety-four cases the onset of acute strangulation had been sudden whereas the onset had been insidious in ten of the sixty-eight cases in which a known femoral hernia had been present for many years. In nearly all cases involving strangulation of a segment of the small intestine (Groups 1 and 2) the onset had been sudden and severe. The acute onset and type of initial pain had been directly related to pathologic changes occurring within the hernial sac.

Periumbilical Pain.   Often this had been the first symptom when a portion of small intestine had strangulated in the femoral ring. At first the pains had been generalized throughout the abdomen but later had localized either to the umbilical region or the affected groin. This type of referred pain has been attributed to increased tension exerted on the mesenteric root[4] and its early appearance usually indicates strangulation of the small bowel and obstruction. When other viscera or structures had strangulated, periumbilical pain had been noted less frequently.

Pain in Groin.   This symptom had appeared with strangulation in patients in Group 2 (92 per cent) and Group 3 (100 per cent) but when loss of viability of portions of the small intestine had been developing, pain in the groin had been secondary to the overwhelming, acute

abdominal manifestations of obstruction of
the small bowel. Usually, pain in the groin
had been localized to the femoral region
and had been described as sharp, gnawing,
burning, or stinging in quality.

Colicky Pain. When strangulating small

Group 2 and Group 3 the constant pain
had originated mainly in the affected groin.

Mass in Groin. A painful, tense, irre-
ducible mass in the groin had been noted
in 100 patients (96 per cent). Although it
had appeared with strangulation in most
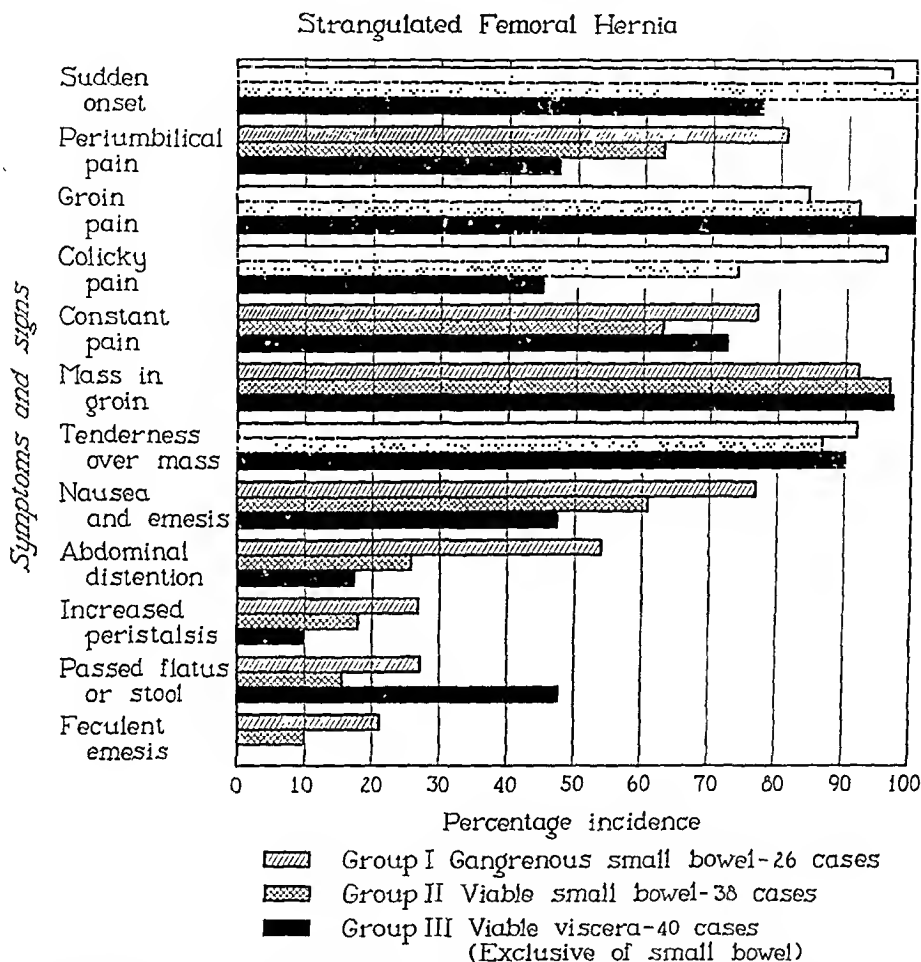
Fig. 1. Significant clinical signs and symptoms in 104 cases of strangulated femoral
hernia.

intestinal obstruction had been develop-
ing, colicky, cramplike abdominal pains
had been the chief complaint. Colicky
pains in the groin often had appeared as
the first symptom in the presence of
Richter's hernia. When portions of cecum
and sigmoid flexure had been strangulated,
the colicky pains had been referred to the
hypogastrium.

Constant Pain. Usually, constant pain
had appeared as a late symptom in all
cases. In the patients in Group 1 it had
been abdominal in origin but in those of

instances, its significance often had been
unappreciated.[2,3] The mass gradually had
increased in size as pathologic processes
had developed within the strangulated
hernial sac. Local tenderness had been
noted in ninety-five cases but discoloration
of the skin overlying the mass in the groin
had been observed in only ten cases and
in each instance a portion of gangrenous
small intestine had occupied the hernial
sac.

Nausea and Emesis. Some degree of
nausea and emesis had been manifested

in seventy-one patients, corresponding directly with the seriousness of the condition in each case. Nausea and emesis had occurred in the later stages of strangulation but had been more protracted in cases of obstruction of the small bowel. Feculent emesis had been noted in nine cases of strangulation of portions of small intestine and usually it had appeared about twenty-four hours after the onset of acute strangulation.

Abdominal Distention. The distended abdomen characteristic of ileus had been observed and recorded in 54 per cent of the patients in whom the small bowel was involved. Audible peristalsis had been noted previously but it diminished in intensity as distention increased.

Expelled Flatus or Stool after Onset. In cases of strangulation exclusive of portions of the small intestine 48 per cent of the patients had expelled flatus or fecal material or both after the onset of acute strangulation, whereas in cases of strangulation of portions of small bowel only 18 per cent of the patients had passed flatus. The voluntary passage of flatus or stool per rectum should be considered a good indication of the presence or absence of strangulation of a portion of the small bowel with obstruction.

A known femoral hernia had been present in sixty-eight patients for periods ranging from two weeks to forty years. Intermittent intestinal obstruction had been experienced by sixteen of these patients and at operation for acute strangulation gangrenous portions of the small intestine were found in eleven hernial sacs. Thus, the inherent dangers of an untreated femoral hernia should be obvious.

SUMMARY AND CONCLUSIONS

By careful review of the clinical manifestations exhibited in 104 cases of strangulated femoral hernia it is obvious that acute strangulating types of small intestinal obstruction produce a very dramatic onset. The rapid progression of symptoms and signs indicates the rate of pathologic

degeneration within the hernial sac. Therefore, when a segment or loop of the small intestine is strangulated in the femoral ring, the clinical picture presented is one of acute intestinal obstruction with such various degrees of prostration and shock that the femoral hernial process is often unheeded.

When abdominal or pelvic structures other than portions of small intestine are strangulated, the primary symptoms and signs usually indicate acute femoral herniation, whereas late manifestations may be referable to the structures involved. However, in all cases of strangulated femoral hernia the character and severity of the initial clinical symptoms and signs indicate the grave seriousness of the disease. Immediate cognizance of these manifestations should assure earlier surgical treatment and a more favorable prognosis.

It is acknowledged that numerous factors contribute to the high fatality rate associated with strangulated femoral hernia. Many of these contributory elements are individual responsibilities that offer few prospects for improvement of this situation unless the layman is re-educated to recognize the manifestations of impending strangulation. Too often the liability for fatalities is attributed to the advanced age of the patients without giving sufficient consideration and recognition to other probable causes for failure.

It has been demonstrated in the 104 cases of strangulated femoral hernia studied by one of us (J. P. J.) that age alone is not ample justification for the rendering of an unfavorable prognosis. It is our observation and conclusion that the prognosis should be determined after evaluation of the pathologic condition of the strangulated viscera when they are visualized and treated at operation. In cases of strangulation of parts of the small intestine, when surgery has been delayed and irreversible pathologic changes have taken place, the prognosis is very grave for a person of any age. Since physical resistance in the aged is materially lowered, such

persons are benefited most by early surgical treatment but the prognosis should be influenced more by the condition of the strangulated viscera than by the factor of age alone.

The grave seriousness of strangulated femoral hernia involving a segment or loop of small intestine has been discussed. If the clinical evidence is considered and interpreted as directly indicative of the degree of strangulating obstruction, perhaps many operations may be performed earlier before irreversible pathologic changes occur.

An intimate relationship has been found to exist between the character of the contents of the hernial sac and the clinical manifestations. Careful evaluation of these components is essential for the rendering of a dependable prognosis. It is hoped that

adequate realization and a more comprehensive understanding of the serious problems presented by strangulated femoral hernia will result in benefits for everyone concerned.

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ARTERIAL INJURIES*

AN ANALYSIS OF THE IMMEDIATE AND LATE RESULTS OF ARTERIAL INJURY BASED ON MILITARY EXPERIENCE

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AN unusual opportunity to observe both the immediate and late results of arterial injuries was afforded us in a U. S. Army General Hospital in England where fresh battle casualties from the Eighth Air Corps and older casualties evacuated from the continent were treated during the recent war.

Although most of these wounds were open ones from stabbing, gunshot or shell fragment, such closed wounds as supracondylar fractures of the humerus, dislocations of the knee or fractures of the upper portion of the tibia with posterior displacement[1] (Case II) also may be the cause of arterial injuries with gangrene or ischemic contractures of the involved extremities.

In either open or closed wounds the injury to the artery was found to be either one of spasm, contusion or laceration. Arterial thrombosis was a possible complication in all of these injuries.

ARTERIAL SPASM

Spasm occurs not only after severance or laceration of an artery but also after concussion or contusion of a vessel. It is a normal reaction of the artery to injury and is primarily a protective one to enable bleeding vessels to become occluded spontaneously before exsanguination occurs.

In some instances this spasm may be harmful[2] in that it may persist for a matter of hours not only in the injured segment of an artery but also in the main trunk, proximal and distal to the injury. It may follow a blow or a fracture, the application of a tourniquet or the passage of a missile close to a vessel. If unrelieved, it may lead to gangrene of the extremity.

If serious complications from ischemia are to be avoided, the spasm must be relieved within six hours. This may be accomplished by a paravertebral procaine injection of the sympathetic ganglia, by brachial plexus block or spinal anesthesia. If these measures are not successful, the artery should be exposed to make sure that some other cause of vascular occlusion is not present, such as compression (Case II) or thrombosis (Case III). In our experience local procedures such as lavage of the vessel with warm solutions, massage of the vessel or periarterial injections with novocain to relieve spasm have not been effective (Case I).

Case I. E. J., 31288902, a gunner on a B-17 heavy bomber, was hit by a shell fragment from flak over enemy territory August 5, 1944, and was admitted five hours later with a 2 by 3 cm. wound over the tibia anteriorly at the junction of the middle and upper one-third. His calf was swollen taut. Neither posterior tibial nor dorsalis pedis artery could be felt to pulsate. His foot was a little cooler than the normal one but was of good color. The tibia was fractured. At operation a long medial incision was made, retracting the gastrocnemius and soleus muscles posteriorly. This gave excellent exposure to the vessels in the posterior compartment where the peroneal artery was found to be divided 3 cm. distal to its origin from the posterior tibial. The posterior tibial artery was in spasm and did not pulsate. It did not appear abnormal otherwise. The peroneal artery was ligated. Lavage of the wound with warm salt solution and periarterial injection of procaine did not affect the spasm in the posterior tibial artery. A cast was

applied and the lumbar sympathetic ganglia blocked with procaine. Normal pulsations were present at the ankle on the following day.

CASE II. A. M., No. 32813602, a waist gunner on a B-17 heavy bomber, was hit by flak on September 10, 1944, and admitted six hours later with comminuted fracture of the upper portion of left tibia and a 2 by 3 cm. wound of entry on the anterior surface of the left tibia 8 cm. below the knee joint and a 4 by 10 cm. wound of exit posteriorly over the upper calf extending to the popliteal fossa. The left foot was pallid, cold, pulseless and anesthetic and he was unable to move his toes. On exploration the posterior tibial artery was found to be in spasm although feeble pulsations were present down to a point about 6 cm. below the knee joint where it was caught between the plantaris tendon and a fragment of bone from the comminuted tibia. No pulsation was present below this point of compression. The tendon was divided and the artery lavaged with warm salt solution. After a short time the artery began pulsating normally along its entire extent. The wounds were débrided and a cast applied. At the close of the operation color and warmth had returned to the leg and pulses could be felt at the ankle. Circulation remained normal during his subsequent course.

ARTERIAL CONTUSION

Contusion of an artery may result in its occlusion by spasm or thrombosis. When exposed, the artery is swollen, discolored and feels solid. No pulsation is present. The accepted treatment of arterial contusion is to resect the entire damaged segment of the artery[2] (Case III) because the thrombus present may become dislodged as an embolus or spread to occlude collaterals, and because necrosis at the site of injury may allow secondary hemorrhage or traumatic aneurysm to develop later, and also because the injured artery may set up afferent impulses which maintain vasospasm.

CASE III. P. P. No. 35770207, a gunner on a B-17 heavy bomber, was admitted January 13, 1945, seven hours after having been hit in the left popliteal fossa by a shell fragment from flak while on an operational mission. There was a perforating wound from side to

side through the popliteal fossa. Blood loss had not been excessive and his general condition was excellent. There was no fracture. The foot was pallid, cold, pulseless, insensitive and he was unable to move the toes or ankle.

Upon exploration the popliteal artery was found to be discolored and firm over a distance of about 4 cm.. It did not pulsate. A short, transverse incision was made in the artery and a 3 cm. segment of clot extracted. The artery above and below the area of thrombosis was in spasm and only a feeble flow of arterial blood followed the extraction of the thrombus. The contused segment of artery was resected and a vein graft prepared on two Vitallium tubes using a segment of the popliteal vein. Although the smallest tubes were used, it was impossible to insert the tubes with the graft into either arterial end because of spasm of the artery which could not be relieved by lavage of the wound or periarterial procaine injection. The vein graft had to be discarded. By flexing the knee it was found possible to do an end-to-end arterial suture. At its completion no pulsation was present in the artery distal to the suture. At the close of the operation the foot remained ischemic. Repeated paravertebral injections with procaine failed to change the condition. Heparin was not available. On amputation two days later the involved segment of the artery was occluded by thrombus.

LACERATION OF AN ARTERY

The most common arterial injury is caused by laceration. We found that 5.4 per cent of extremity wounds in Air Corps casualties[3] were arterial wounds. (Table I.) Its dangers include hemorrhage, ischemia, traumatic aneurysm, arteriovenous fistula and secondary hemorrhage.

ARTERIAL HEMORRHAGE

The lacerated artery may be completely severed or only perforated or partially divided. When an artery is completely severed, its ends retract, go into spasm and become occluded by thrombi. In a partly divided artery where retraction is impossible the opening in the vessel gaps and continues bleeding.

Holman[4] has shown in the experimental animal that when a femoral artery was

completely divided, the loss of blood was 30 cc. before the bleeding stopped spontaneously. On the other hand, when the artery was cut through only half of its circumference, the animal bled to death, the average loss of blood being 300 cc.

loss is to be held to a minimum and adjacent nerves are not to be damaged. A tourniquet may be used to insure a bloodless field. If the wound is too near the groin or axilla for the use of a tourniquet, the artery above the injury should be

TABLE I

LOCATION OF 863 WOUNDS IN 645 FRESH AIR CORPS CASUALTIES

	Per cent of Total	No. Wounds	Complicated Wounds
Head and neck	20	173	25 Cranial penetrations 3 Major artery face and neck
Trunk	11	96	41 Pleural or peritoneal penetration
Extremities	69	594	32 Major artery wounds 5.4% 48 Peripheral nerve 8.0% 183 Compound fracture 21.2%

Our experience substantiates this experimental evidence for in every case of traumatic aneurysm, arteriovenous fistula and secondary hemorrhage, and in most cases in which severe primary loss of blood has been a factor, partial rather than complete severance of the artery has been the injury present.

Recognition. In fresh wounds arterial lacerations may be suspected if blood loss has been excessive, if deep swelling in fascial compartment traversed by arteries is present or if arterial pulsations are diminished or absent in the part distal to the wound with or without signs of ischemia. None of these signs need be present even with a partially divided artery, however (Case IV).

When the wound is being explored the presence of a small mass of dark blood clot in a location adjacent to an artery should warn the operator of a possible arterial injury (Case IV). The sudden gush of arterial bleeding which follows the dislodgment of such a clot is often difficult to control if preliminary precautions have not been taken.

Management. When an arterial injury is suspected, adequate operative exposure plus some means of temporarily occluding the bleeding vessel is necessary if blood

exposed and a tape placed around it for temporary occlusion until the damaged vessel is dealt with. If arterial bleeding is suddenly encountered, it should be temporarily controlled by pressure with the finger or a pack.

Whenever it is necessary to ligate an artery, the vessel should be completely divided. If ligated in continuity the constant battering of each pulse beat against a fixed point will often result in erosion of the vessel and secondary hemorrhage. This will not occur if the vessel is divided and its end is free to retract and to move with each pulse. It is best to ligate each end doubly, the distal ligature being one which transfixes the vessel wall.

Ligation of the accompanying vein as a means to improve the circulation in an extremity deprived of its circulation has been repeatedly advocated in the past. However, the collected figures on arterial injuries of World War II by DeBakey and Simeone[5] indicate that concomitant vein ligation does not increase the chance of survival of the limb. We have used concomitant vein ligation in all of our cases.

ISCHEMIA

When an artery is occluded, the development of signs of ischemia depends upon

the adequacy of circulation through collateral channels. The adequacy of this collateral circulation is dependent upon certain anatomic limitations at the site of the injury and upon whether these collateral channels are damaged by previous collateral circulation exists and where signs of ischemia are most likely to follow arterial occlusion are in the popliteal artery and in the femoral artery above the profunda branch (common femoral).

DeBakey and Simeone[4] in an analysis of

TABLE II

METHOD OF TREATMENT IN THIRTY-FIVE FRESH ARTERIAL WOUNDS

	Ligated	Sutured	Immediate Amputation	Delayed Amputation
1 Common carotid		x		
1 Internal maxillary	x			
1 Costo-cervical trunk	x			
1 Subclavian (mediastinal)	x			
2 Brachial (upper ⅓)	x			
1 Brachial (at elbow)	x			
2 Radial and ulnar		x	x	
1 External iliac (with deep epigastric)	x			x
			x	
	x	x	x	
6 Femoral	x		x	x (Gas gangrene)
2 Profundus femoral	x			
				x (Gas gangrene)
		x	x	x
5 Popliteal	x	x	x	x
9 Posterior tibial	x			
3 Peroneal	x			
35 Total	24	5	6	5

disease or by the same injury which divided the original artery. It is also dependent on whether they are occluded by spasm, thrombosis or the pressure of a gradually developing hematoma.

The ultimate fate of the tissues of an extremity after vascular occlusion depends upon the speed with which circulation is restored through these collaterals or by the opening up of the original artery. The tissue most susceptible to injury is muscle. If ischemia lasts six or eight hours and collateral circulation is not fully adequate then, muscles undergo necrosis and Volkmann's ischemic contracture develops. On the other hand, skin can survive ischemia for as long as twenty-four hours. If the collateral circulation is wholly inadequate after this length of time, no tissue survives and gangrene results.

The sites where anatomically inefficient

2,471 collected arterial injuries from World War II found the incidence of gangrene following injuries to various arteries to be as follows: common femoral 81.1 per cent; popliteal 72.5 per cent; brachial above profunda 55.7 per cent; superficial femoral 54.8 per cent; common iliac 53.8 per cent; external iliac 46.7 per cent; brachial below profunda 25.8 per cent.

Rose, Hess and Welch[6] had a similar experience in 100 personally observed cases. In our own series of thirty-five cases gangrene developed only after common femoral and popliteal artery occlusions. (Table II.)

In the case of injury to the common femoral or popliteal artery and possibly also in the brachial above the profunda, in the common carotid and in the femoral artery below the profunda, if collaterals are injured, some effort to restore circula-

tion in the divided vessel should be attempted.

Arterial suture is the best method of restoring circulation in lacerations which do not involve the entire circumference of the vessel. Suture is also advisable in those cases of complete severance in which there has not been too much loss of tissue.

We have done arterial suture five times (Table II) once in the common carotid, once in the radial artery where the ulnar also was divided, once in the femoral and twice in the popliteal artery. Both popliteal sutures were unsuccessful. The one femoral artery suture was known to be followed by thrombosis although the leg did not become gangrenous.

The technic of arterial suture is not difficult. It is wise to trim away any redundant adventitia first and then to use a one-layer suture of fine silk which everts the intima instead of an inverting suture as is used in intestinal sutures.

DeBakey and Simeone report eighty-one arterial sutures from their collected series of arterial wounds in 35 per cent of which subsequent amputation became necessary because of gangrene.

CASE IV. A. M., T-123581, a flight officer and navigator on a B-17 heavy bomber, suffered multiple, small, penetrating wounds of the left side of the neck, left forehead, left forearm and hand from 20 mm. cannon shell fragments on April 19, 1944. He was admitted three hours later in excellent condition. There were three small puncture wounds along the left side of his neck over the mid-portion of the sternocleidomastoid muscle with very little deep swelling under these wounds. There were also multiple wounds of the left forearm, wrist and hand with a partial ulnar nerve palsy and a fracture of the ulna, pisiform and triquetrum.

The neck wound was explored with a single incision which connected the three punctures. The sternomastoid was retracted and a dark clot about 2 by 3 cm. in size was seen plugging a hole in the carotid sheath at the level of the inferior margin of the thyroid cartilage. The clot was not disturbed until a tape had first been put around the carotid artery above and

below it. With the tapes tightened, the clot was extracted and found to be plugging a transverse laceration through half the circumference of the common carotid artery. The ragged margins of this laceration with attached adventitia were trimmed away and the laceration closed with interrupted sutures of No. 000 eye silk threaded on small artery needles. At the close of the procedure when the tapes were removed, the artery was seen to pulsate normally on each side of the suture.

Observed for six weeks, he continued to have a normal temporal artery pulsation on the affected side without evidences of an aneurysm. Subsequent correspondence eighteen months later indicated no further trouble with the neck wounds.

Vein Graft. The principle of non-suture anastomosis using a vein graft and Vitallium tubes was developed by Blakemore in 1942. By this method a vein graft is used to line two Vitallium tubes. After being threaded through the two tubes, the vein is folded back over each tube end which is then inserted into the cut ends of the artery and tied there. The procedure is not as simple as it sounds. We used it once, unsuccessfully, in the case of a popliteal artery in which it was necessary to resect a long segment which was contused and thrombosed (Case III). DeBakey and Simeone report forty vein grafts in their collected series of 2,471 artery wounds in which the amputation rate was 57 per cent. This was higher than the incidence of gangrene after simple ligation.

Plastic tubes were used to bridge temporarily an arterial gap by intubation in fourteen cases in DeBakey and Simeone's series. In 50 per cent of these subsequent amputation was necessary. The object of the tube anastomosis is the temporary maintenance of circulation while collateral circulation is developing. The technic of repair is simple as the tube need only be inserted into each end of the vessel and tied there. Heparinization is essential, because otherwise, the tube will soon become occluded by a thrombus. The usual practice is to remove the tube in four or five days and substitute a vein graft if

it is necessary to bridge the gap for a longer period of time.[7] We have had no experience with this procedure.

Heparin. One of the causes of failure in an attempt to restore circulation in a lacerated or resected artery is the development of thrombosis at the site of the suture or graft. Heparin was not available to us in any of our sutures. It should be used in all vascular wounds of civilian practice when reconstruction of the vessel is attempted.

Management of the Ischemic Extremity. Since vasospasm is a natural response to arterial trauma from either injury or operation and since the vasoconstrictor impulses are transmitted by way of the sympathetic nerve fibers, a sympathetic block by procaine injection of the ganglia supplying the affected extremity is a rational and worth while procedure. It is wise to continue the sympathetic blocks at four- to 8-hour intervals until the fate of the extremity is no longer in doubt.

Refrigeration of the ischemic extremity has been enthusiastically recommended[9] as a means of lowering the metabolism of an injured part to a level commensurate with its reduced circulation and thus, possibly, of saving extremities which otherwise would become gangrenous. However, well controlled studies by Large and Heinbecker[10] have shown that after refrigeration healing is impaired, wound infection tends to progress more rapidly and nerves in the cooled area are liable to damage. Moreover, it is known[11] that at reduced temperatures liberation of oxygen from oxyhemoglobin in the tissues is impaired. Our present belief is that refrigeration has no place in the management of an ischemic extremity except to diminish toxic absorption from an infected limb prior to amputation.

It is wise to keep the ischemic limb cool by leaving it exposed to room temperature or by covering it with a wet cloth onto which a fan is allowed to blow during hot weather. Heat should not be applied to the ischemic extremity.

Posture. The affected extremity should not be elevated for then the feeble trickle of blood under reduced arterial pressure may be unable to ascend into the elevated foot. It is better to keep the extremity in a slightly dependent position and at complete rest.

TRAUMATIC ANEURYSM

When a wounded artery does not communicate with the outside, with a body cavity or a vein, it bleeds into the surrounding tissues. If nature's efforts to stop the bleeding by retraction, spasm and thrombosis is ineffective, bleeding continues as is the case particularly in arterial wounds when the vessel is only partially severed. A hematoma of limited or wide extent develops depending on how yielding the surrounding tissues are. In the natural development of this hematoma a time is soon reached when the blood ejected through the hole in the artery with each heart beat compresses the clot into a laminated layer which surrounds and confines a pulsating sac of blood. Eventually, endothelium may grow around the entire circumference of this sac and the conversion of a pulsating hematoma into a traumatic aneurysm is completed.

The hematoma is hard and does not pulsate the first day after wounding. Its true nature is suspected from the location of the swelling deep in a fascial compartment traversed by an artery. Appropriate means of caring for the injured vessel should be taken immediately.

Most injuries of this nature are not seen until some time after the injury. The arterial wound either was not detected immediately or bleeding into the tissues did not take place until later when a clot occluding an opening in the vessel became dissolved or was dislodged. When seen later, pulsation in the hematoma mass usually may be detected. The appearance of a bruit which is intermittent and synchronous with the pulse may not appear until later.

When an arterial hematoma is not

increasing in size, it is best left alone for three months in order to allow collateral circulation to develop to its maximum extent. On the other hand, if the hematoma is increasing in size, immediate operation may be necessary because of the pain of pressure on adjacent nerves (Case v) or because of the danger of occluding collateral channels from pressure of the expanding hematoma. Infection or secondary hemorrhage are also indications for immediate operation. These indications necessitated early operation in twelve cases of pulsating hematoma in our hands.

The operative procedure necessary for the management of an arterial hematoma or traumatic aneurysm is some form of intrasaccular control of the arterial openings after the method first described by Matas in 1888.[12] This procedure has stood the test of time as the best one to cure aneurysm and preserve the maximum amount of collateral circulation.

The operation is done under a tourniquet, if possible. If the position of the aneurysm precludes the use of a tourniquet, a tape is placed about the artery proximal and distal to the aneurysm in order to obtain temporary control of arterial bleeding. The sac is then opened being careful not to damage adjacent nerves and all clots are extracted from the sac with the hand. Adequate retraction of the walls of the aneurysm then makes identification of the openings of the artery within the sac easy. These are then controlled by sutures placed from within the sac. This was the procedure used in 60 per cent of the 110 aneurysms operated upon by Elkin at the Army Vascular Center at White Sulphur Springs, W. Va.[13] The remaining 40 per cent were small aneurysms in association with nerve injuries in which excision of the entire sac and ligation of the vessel on each side was done. In Elkin's series of cases in which operation was deferred three months and the Matas operation was used, there were no recurrences of the aneurysm and none of the limbs became ischemic.

CASE V. L. D., No. 33212938, an infantry private, received a small wound over the inner aspect of the right arm near the elbow from 88 mm. shell fragments on June 23, 1944. He was admitted on June 28th with diffuse swelling along the medial aspect of the right arm just above the elbow and in the anticubital fossa. There was complete median nerve palsy. The radial artery could be felt to pulsate. By July 16th a pulsating mass approximately 6 by 6 cm. in size had developed over the medial aspect right arm just above the elbow and he had been having continuous, severe, burning pain over the median nerve distribution, which was poorly controlled by opiates throughout the preceding week. Operation on this day showed a pulsating hematoma with a longitudinal laceration in the brachial artery just above the lacertus fibrosus. The median nerve was intact but somewhat swollen. The clot was evacuated and the artery doubly ligated and divided. Followed for one month after operation, the median nerve pain had entirely disappeared and median nerve function was returning. The radial pulse had been present since the operation. Residual induration in the region of the brachialis muscle prevented full extension of the elbow.

ARTERIOVENOUS FISTULAS

When an artery and its accompanying vein are partially severed by the same missile, the wounded artery may bleed into the vein and a permanent fistula between the artery and vein may develop. Such wounds are usually small and often do not cause immediate concern as blood loss is usually not excessive. The true state of affairs is often unrecognized until much later when the patient or a physical therapist accidentally discovers the peculiar, continuous buzzing thrill which may be felt over the lesion.

The symptoms caused by an arteriovenous aneurysm are dependent upon the caliber of the fistula. Large aneurysms may be incompatible with life while small ones may give no symptoms and may even close spontaneously. Untoward symptoms include the effect of the fistula on the heart and on the circulation in the involved extremity. The fistula introduces a point

where peripheral resistance is suddenly lost. The body compensates by increasing the circulating blood volume. This throws an extra load on the heart which may fail in time if the fistula is not closed. The affected extremity may show an increase in its venous pressure with edema, distended veins and varicose ulcers. If the fistula is large, signs of ischemia may develop. Usually these local changes in the extremity are inconspicuous.

Locally, the fistula is recognized by the continuous thrill on palpation and by the prolonged machinery-like murmur on auscultation. This bruit is in contrast to the intermittent murmur synchronous with the pulse heard over simple aneurysms. When the site of the fistula is closed by compression with the finger, an abrupt rise in blood pressure and fall in pulse rate occurs. These phenomena are characteristic of an arteriovenous fistula as they do not occur in the presence of other arterial injuries.

Management. Since the presence of an arteriovenous fistula is recognized as a stimulus to the production of collateral channels, operative interference is withheld for at least three months in order to allow maximum production of collateral circulation unless some reason for immediate operation develops. Another reason for delaying operation is that small fistulas sometimes heal spontaneously.

At operation the accepted procedure is quadrilateral ligation and excision of the fistula with the involved segment of artery and vein. Theoretically, it might seem advisable to attempt some means of repair by which the arterial circulation may be preserved by tying off the fistula or repairing the artery by a transvenous route. Actually, however, such a procedure is seldom possible technically. As a matter of fact the possibility of recurrence after these reconstructive procedures is so good and the possibility of gangrene after the quadrilateral ligation and excision technic so remote that all but the latter procedure have been abandoned in most vascular clinics.

Elkin[13] has probably had a larger experience with this lesion than anyone else in the world. He reported 340 arteriovenous fistulas treated at the Vascular Center of the Ashford General Hospital in White Sulfur Springs; 328 patients were treated with quadrilateral ligation and excision and operative repair was successful in only twelve. Gangrene did not develop in any of the involved extremities and there were no recurrences. Ten of his patients had two arteriovenous fistulas each while three patients had three fistulas each.

Our civilian experience far outweighs our military knowledge of the operative repair of these fistulas, as they seldom give immediate trouble and Army directives required that patients should be sent to the Zone of the Interior for definitive care.

The operation is usually done without a tourniquet as the filled vessels are more easily identified. The entering artery is often greatly dilated and thinned. First a tape is placed about it for temporary control if bleeding should occur. The artery and vein distal to the fistula are then ligated and divided; the proximal artery is then divided and the proximal vein is ligated last in order to allow an exit for blood entering the fistula. Numerous tributaries are divided as the fistula is excised.

All writers warn against the dangers of proximal arterial ligation (a procedure somtimes used for simple aneurysms) when dealing with an arteriovenous fistula. Such a procedure shuts off the major arterial inflow. The small amount of blood now entering the artery through collaterals is immediately shunted into the vein and does not reach the periphery of the extremity. Grave ischemia or gangrene is the usual result.

CASE VI. G. V., No. 39170422, an infantry rifleman, suffered a small, penetrating, shell fragment wound in the left groin August 8, 1944. The wound bled very little and healed promptly. He had been unable to extend the leg at the knee since the injury. When he was received by transfer on August 29, 1944, there

was a 2 cm. healed wound over the femoral vessels just below the inguinal ligament on the left. A continuous thrill was palpable and a prolonged machinery-like murmur was heard in this area. No edema or venous engorgement was present in the leg. The heart was not enlarged by x-ray. The dorsalis pedis and posterior tibial vessels pulsated, although less forcefully than on the right. Closure of the fistula by digital pressure resulted in an immediate elevation in blood pressure from 112 to 136 and a fall in pulse from 88 to 72. A complete femoral nerve palsy was present.

Because of the danger of ischemia following ligation of the common femoral artery before adequate collateral circulation was developed and in accordance with Army Regulations, he was evacuated to the United States for operation after three months.

SECONDARY HEMORRHAGE

Hemorrhage from an artery which has been temporarily occluded by a thrombus or ligature may occur when the clot becomes liquified or dislodged or the suture absorbs. The usual time for this to occur is from the tenth to the sixteenth day. Approximately 1 per cent of those patients injured by missiles developed secondary hemorrhages in World War II.[5,14]

The first warning of its presence may be a sudden exsanguinating hemorrhage from a wound. Often there is a little bloody discharge for a day before the alarming hemorrhage occurs. Bleeding may be stopped temporarily by a pack. It is folly to expect such bleeding to stop spontaneously or to expect that proximal ligation of the artery above the wound will be effective. The only way to control secondary hemorrhage is to open the original wound and, with adequate assistance, visualize, ligate and divide the partially lacerated and bleeding artery (Case VII).

Our experience included fourteen cases of secondary hemorrhage. Two were from intercostal arteries, one from the obturator artery which was bleeding into the bladder, while the others were in extremity wounds.

CASE VII. R. S., No. 38088515, an infantry sergeant, was hit by 80 mm. shell fragments in his left thigh on November 29, 1944. Bleeding was profuse and controlled in an evacuation hospital five hours later where local débridement and packing was done. He was admitted by transfer eight days later having oozed a little bright red blood from the wound daily since the injury. On the morning of the ninth day there was massive arterial hemorrhage from the thigh wound which was found to be a perforating wound from the anterior to the posterior surface through the medial half of the thigh at the junction of the middle and lower one-third. The wound was explored under a tourniquet and the femoral artery was found to be partially divided in the middle of the thigh. It was doubly ligated and divided. After operation the foot remained warm and of good color though pulses could not be felt at the ankle. Two months later he complained of cramps in the calf after walking ¼ mile. At this time the posterior tibial and dorsalis pedis arteries could be felt to pulsate, although less vigorously than on the unaffected side.

SUMMARY AND CONCLUSIONS

Acute arterial injuries occurred in 5.4 per cent of extremity wounds of fresh Air Corps battle casualties.

Cases illustrating arterial spasm, arterial contusion and laceration of arteries are described.

Examples of the complications of arterial injuries which include arterial hemorrhage, acute ischemia of an extremity, traumatic aneurysms, arteriovenous fistulas and secondary hemorrhage are presented.

The recognition and management of these injuries and their complications are discussed.

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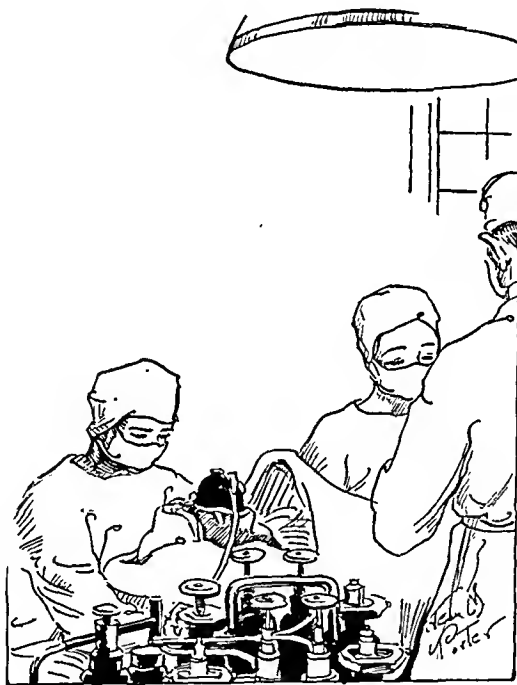
VAGINAL AND CERVICAL SMEARS
IN UTERINE MALIGNANCY*

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IN 1928 Papanicolau[1] discovered that cancer cells could be recognized in the vaginal smear. For many years he had studied the cytology of vaginal smears and found that pathologic conditions of the genital tract confused the picture of the normal cellular content. In 1941 Papanicolau and Traut[2] described in greater detail the cytology of malignant tumors of the female tract. In 1943 Papanicolau and Traut[3] published a monograph describing the technic and cytology of carcinomas in detail. Since then, other investigators such as Meigs[4] in 1943 and Ayre[5] in 1944 and Jones, Neustadter and Mackenzie[6] have confirmed the value of this procedure.

It has been definitely established that five and ten-year arrests of uterine carcinomas can be obtained if an early diagnosis is made. This is particularly true of squamous carcinoma of the cervix. The choice of therapy is unimportant, the early diagnosis is imperative.

In New York City at the present time cancer detection clinics have been established, and routine smears are being taken although no statistics are available as to the number of asymptomatic cases found. However, at the Health Maintenance—Cancer Prevention Services in Philadelphia, in a booklet covering a two-year study between 1944 and 1946, a total of twenty-four cancers were found, seven of which were in the uterine tract. Cervical smears were taken routinely.

At present in many institutions other secretions, such as urine, sputum, gastric and prostatic, are being investigated for diagnosis of malignancy in these systems. The more smears we do the more strongly we believe that all women over thirty-five years of age should have smears taken every six months. If any cervical disorder is found (excepting carcinoma), it should be treated locally at once and follow-up smears should be taken every three months for a period of at least two years.

It is admitted that there are certain difficulties in technic and interpretation. One of these is that the staining procedure is rather long and cannot be used as an office procedure at present. Another factor is that one who is familiar with hematoxylin and eosin stained tissues finds these stained cells more difficult to interpret. A third point is the difficulty in evaluating the cells and groups of cells that are exfoliated since there is no basement membrane to determine invasion of underlying structures, and examination of individual abnormal cells, or groups of abnormal cells cast-off, are not in relation to one another. A fourth point is these stained exfoliated cells are much larger than those seen in tissues. However, careful study will reveal the similarity between the tissue cells and exfoliated cells. This makes it extremely important for one to revise his conception of cytology in smears as compared to tissues.

At the New York City Cancer Institute we have modified the technic although the staining process is that used in Papanicolau's laboratory. We will describe in detail our technic, point out the advantages and bring out some important points in staining to aid in obtaining good smears. We will also describe normal, abnormal cells and groups of cells in benign and malignant conditions with the aid of photomicrographs.

TECHNIC

We use a curved glass tube about 10 to 12 inches long which is bent at approximately a 30 degree angle at the junction of the outer two-thirds and the inner one-thirds. The bore at the long end is narrowed to about 4 mm. width, and the short end is attached to a hard rubber bulb. (An ordinary glass drinking tube can be heated down easily to suffice.) A bivalve speculum with no lubrication should be inserted so that the posterior fornix is exposed. Under direct vision the pipet should be inserted with the rubber bulb compressed and any secretion in the posterior vaginal vault aspirated. The direct exposure is very important because in a few patients with a high rectocele or a long vaginal vault with redundant vaginal walls, the aspirated material does not come from the posterior vaginal vault where the exfoliated cells of a malignancy are most likely to be deposited. If there is insufficient secretion to be aspirated, there is usually some secretion to be found on the anterior surface of the posterior blade of the speculum.

As much as possible of the secretion is then "pumped out" of the pipet on to the surface of a labelled clean slide with a clip attached and another clean slide is placed on top. The secretion is pressed evenly between the two slides and immediately immersed in equal parts of ether and alcohol. (This allows an even spread of the smear. Many smears are uneven with some areas too thick and others too thin which prevents good staining.)

A second pipet is then inserted at or slightly in the external os of the cervix, and all secretions that can be aspirated from the cervical canal, external os or on the surface of the cervix are taken. At times the cervical secretions in the canal are too thick and impossible to aspirate. By using a plain wooden applicator and rotating it gently in the region of the external os, sufficient secretion can be obtained on the applicator. This is immediately transferred to a slide and the same procedure as just described is performed. Taking two vaginal and two cervical smears is important. We have examined smears when a positive diagnosis could be made on only one of the four smears taken, the others being essentially negative.

In a patient with profuse bleeding or a profuse vaginal discharge a further modification was adopted due to the fact that the cells or cell groups might be washed out by the flow and that cells would be more difficult to find because of the presence of red blood cells and polymorphonuclear leukocytes in great numbers. We aspirate sufficient secretion to fill one-half of the long arm of the pipet and this is then filtered through a few layers of gauze. The sediment is picked up with a wooden applicator, transferred to a slide and spread as has just been described.

In the actual staining the present Papanicolau technic, using Harris hematoxylin as the nuclear stain and EA 50 with OG 6 as counter stains, seems to be the best. Two precautions should be adopted: (1) the hematoxylin should be filtered daily and (2) the 3 per cent ammonium hydroxide should be checked daily as evaporation will change its strength and clearing of the slide for proper counterstaining is not good.

Endocervical and endometrial smears are not used as a routine. We reserve it only for those cases in which persistently suspicious smears are found, the origin of which appears to be adenomatous in character, or in cases of abnormal bleeding with a persistent negative smear. For this procedure we use a blunt tipped malleable cannula, about 6 inches long that fits on any Luer-lock syringe, with a bore 2 mm. wide. This passes through the internal os of the cervix with ease.

CYTOLOGY

From a practical point of view our cases are classified as normal, suspicious and malignant.

Normal. This group includes all cells, groups of cells normally found during the
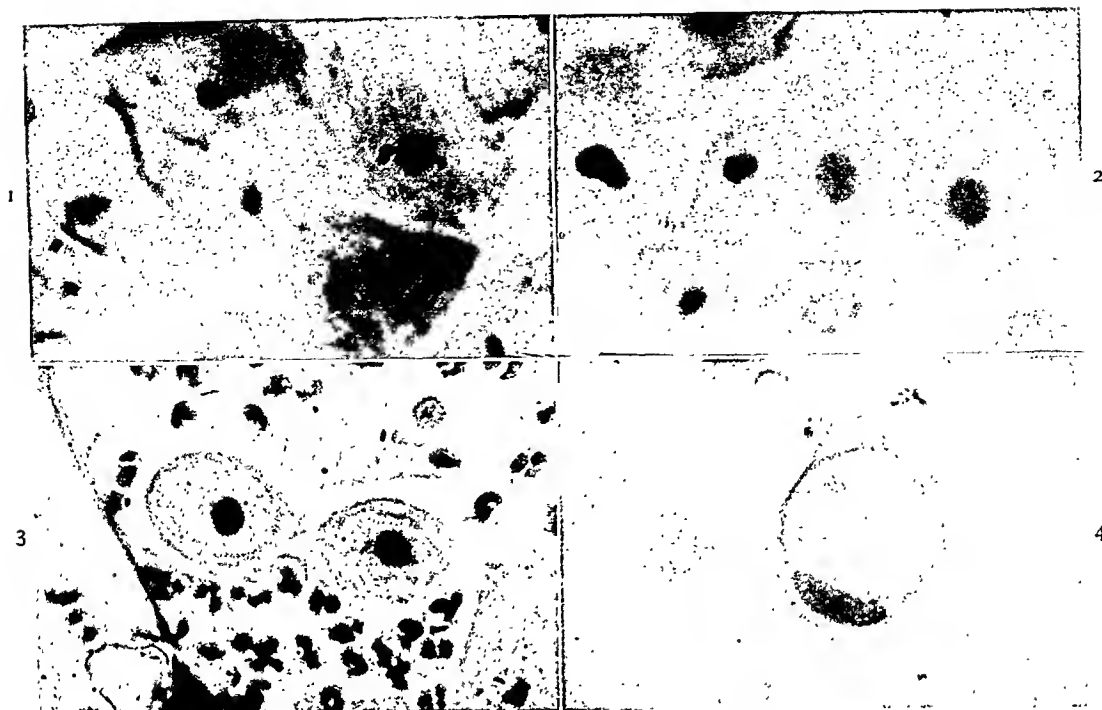
FIG. 1. Superficial squamous vaginal cells large, flat, curled edges, small nuclei.
FIG. 2. Intermediate and basal vaginal cells; elliptic or spindle size between superficial and basal; smaller cell larger nucleus.
FIG. 3. Cervical cells; central nucleus, vacuole in center, heavy peripheral rim.
FIG. 4. Cervical cell; signet ring, nucleus in periphery, large vacuole, heavy peripheral rim.

childbearing or menopausal periods in the vagina or cervix. Figure 1 illustrates superficial squamous vaginal cells. These usually are large, flat, have curled edges and small pyknotic nuclei. They may be acidophilic or basophilic. Figure 2 shows a smear with intermediate and basal cells. The intermediate cell is elliptical or spindle, the size between a superficial and basal cell. It is sometimes vacuolated. Basal cells are smaller, round, with a larger nucleus and, of course, basophilic. Figures 3 and 4 are cervical basal cells. These are vacuolated cells with the vacuole pushing the cytoplasm to the periphery producing a heavy rim. The nucleus may be centrally located or eccentrically placed. Figure 5 shows normal endometrial cells found during the third day of the menses. These cells are small and are usually found in clusters, often with eccentrically placed nuclei.

Benign lesions: Cell groups are seldom found on vaginal smears but more frequently in cervical smears. If groups are

found (1) the nuclei show very little change, (2) there is no change in the nucleocytoplasmic ratio, (3) there is uniformity of the cells, (4) there is no crowding of cells and (5) bizzare cells are not found.

Chronic endocervicitis is illustrated in Figure 6. There is uniformity of nuclei, no crowding of cells, pyknosis of nuclei but no change in the nucleocytoplasmic ratio.

The cervical polyp shown in Figure 7 also shows uniformity of nuclei with no change in the nucleocytoplasmic ratio. These cells are elongated although they may also be round, similar to that found in chronic endocervicitis. Again, there is no crowding of the cells.

Metaplasia, frequently found in cervical lesions and often mistaken for malignancy, is illustrated in Figure 8. The nuclei are fairly large, hyperchromatic and found outside of the cytoplasm. Another type of metaplastic cell is found that is smaller, usually found in groups, with a characteristic vacuolization of the cytoplasm. The
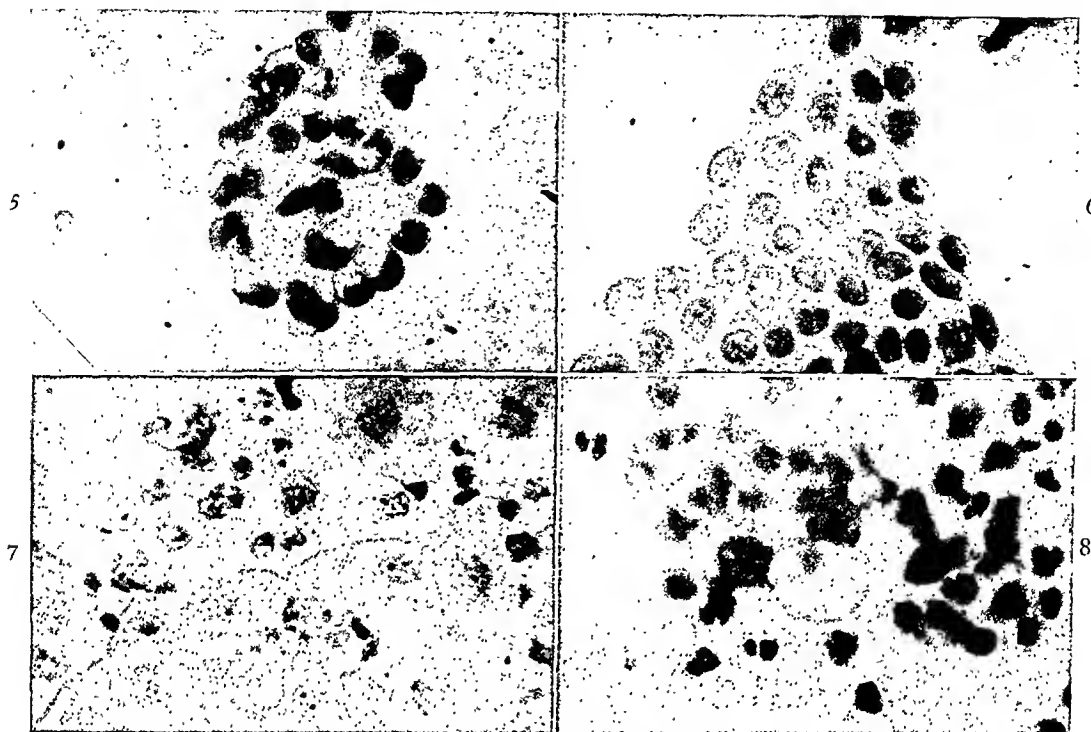
FIG. 5. Endometrial cells, cluster, small round, eccentric nuclei.
FIG. 6. Chronic endocervicitis uniformity of nuclei; pyknotic nuclei.
FIG. 7. Cervical polyp; uniformity of nuclei, elongation of cells, nucleocytoplasmic ratio normal.
FIG. 8. Metaplasia; nuclei found outside cytoplasmic structure.

significance of metaplasia in relation to malignancy has not been fully established.

Suspicious. This classification includes cells or cell groups which show some nuclear changes which are more marked than in the normal. However, insufficient changes are present to permit a positive diagnosis. When a suspicious interpretation of a smear is made, a positive malignant biopsy of the cervix or endometrial curettings must be obtained before any radical therapeutic procedure is adopted.

Malignant. The criteria of malignant diagnosis are specific:

1. Squamous carcinoma of the cervix is characterized by hyperchromatism of the nuclei, changes in the size and shape of nuclei in cells of the same group, change in the nucleocytoplasmic ratio, crowding of the cells in the groups and bizarre forms. In grade I or II the diagnosis is not too difficult. The grade III being less differentiated is at times difficult to distinguish from the adenocarcinoma of the embryonic

type; Figs. 9, 10, 13 and 14 show bizarre types of cells found in squamous carcinomas.

2. Adenocarcinoma produces smaller cells, frequently with prominent nucleoli; abnormal cytoplasmic vacuolization, particularly in the mucoid type and the changes described in squamous carcinomas. Grade I or adenoma malignum does not exfoliate early so that the lesion may be more advanced before being diagnosed. However, since this condition is rather slow-growing, a cure can still be obtained if the diagnosis is made when exfoliation occurs. The grade II–III types exfoliate earlier so that an early diagnosis can be made. There is an admitted 10 per cent error in this type of malignancy and we believe that endometrial and endocervical smears may have to be done more often than done at present in order to decrease the percentage of inaccurate readings.

To determine whether an adenocarcinoma originates from the cervix or corpus is very difficult and at times
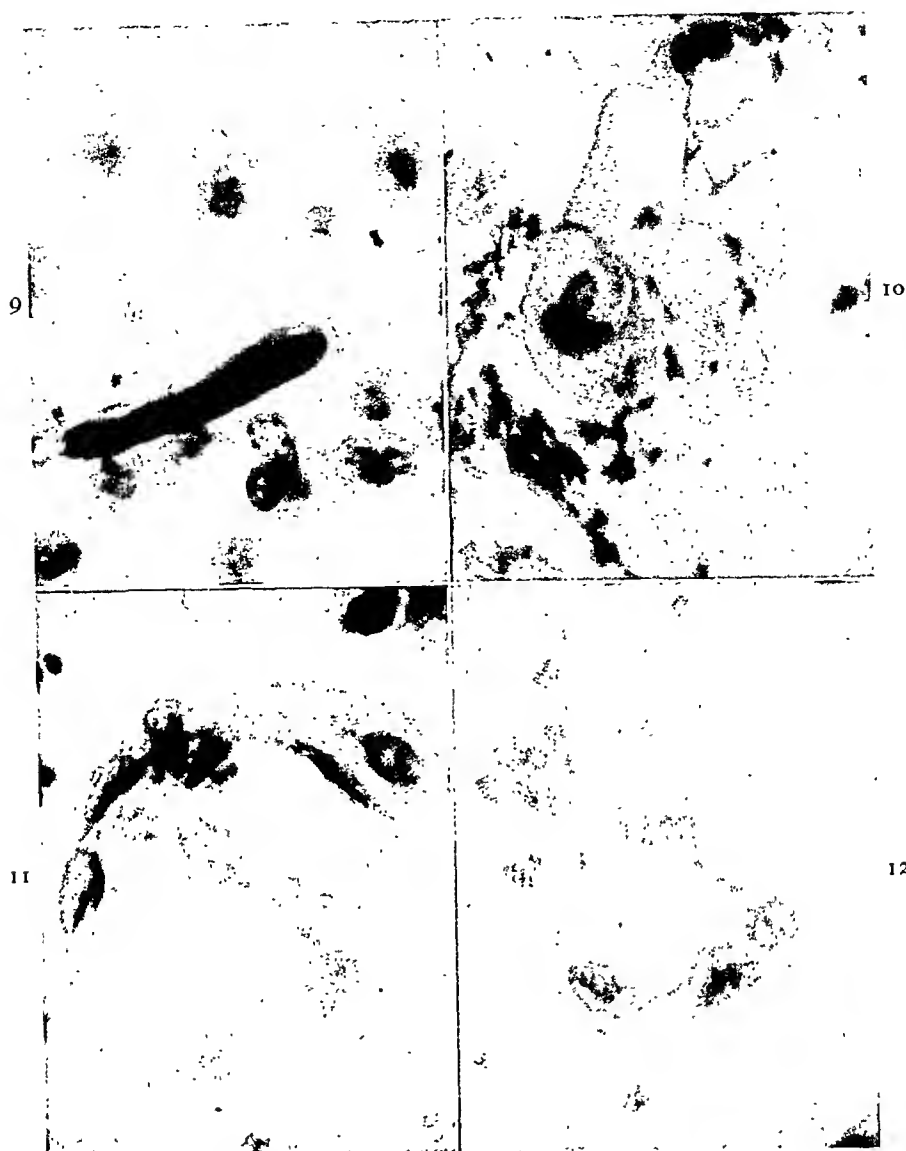
FIGS. 9 and 10. Bizarre cells in squamous carcinoma of cervix; Figure 9 illustrates the fiber type.
FIGS. 11 and 12. Adenocarcinoma of corpus (abnormal vacuolization); hyperchromatism.

impossible. (Figs. 11 and 12.) We believe this is not important from a clinical point of view as long as the diagnosis of malignancy is made. Whenever a positive diagnosis of malignancy is made, the burden of proof to disprove the diagnosis rests with the gynecologist.

A brief resume of six cases bring out the various important points of smears.

CASE REPORTS

CASE 1. Mrs. M. L., a white female aged forty-four, was seen in our clinic in June, 1946

for lower abdominal pain. Pelvic examination was negative. The cervix revealed a mild erosion; a diagnosis of mild chronic cervicitis was made and no treatment was given. Smears were not taken in our clinic at this time. She returned in January, 1947 for a routine check-up. No complaints were given. Pelvic examination revealed the same mild erosion. At this time smears were being taken on all patients examined in our clinic. The smear revealed a definite squamous carcinoma of the cervix. (Fig. 15.) She was admitted to the hospital where a biopsy was reported as preinvasive carcinoma of the cervix. (Fig. 16.)
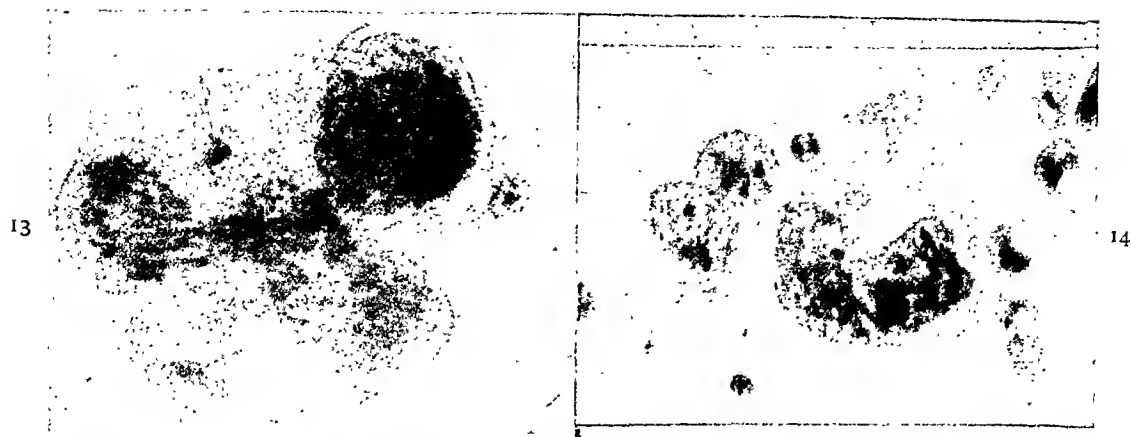
FIGS. 13 and 14. Bizarre cells in squamous carcinoma of cervix; Figure 13 is the clover type; Figure 14 the horseshoe type.
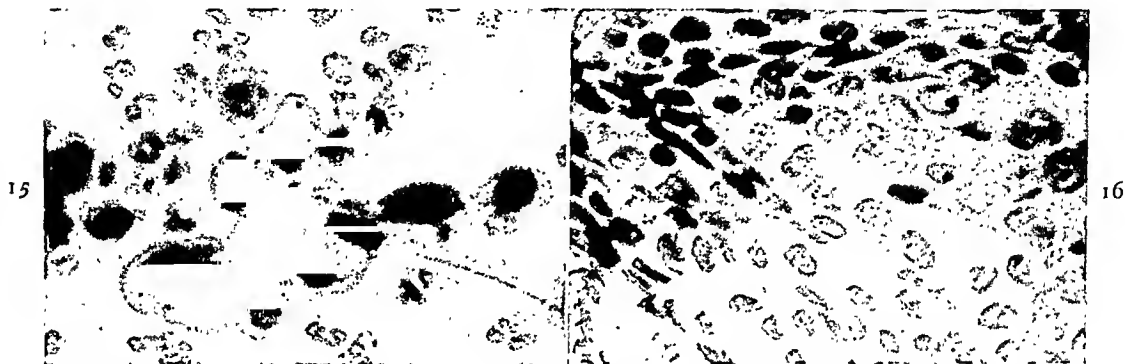
FIGS 15 and 16. Group of cells found in intra-epithelial carcinoma of cervix; Figure 16 is a tissue section.

She received proper treatment and was discharged in excellent condition.

CASE II. Mrs. V. P., a colored female aged thirty, was admitted to the New York City Cancer Hospital in January, 1947 with the following history: for the past year she menstruated approximately every third month eight to nine days instead of the usual three to four. No intermenstrual bleeding was present. Pelvic examination revealed an ulceration at the cervical os extending down one-half of the posterior lip. The examination of the parametria, adnexa and uterus was essentially negative. Smears revealed a positive diagnosis of squamous carcinoma of the cervix. (Fig. 17.) The first biopsy revealed chronic cervicitis but no carcinoma. The smears being definitely positive, a second biopsy was taken. The pathologic report was epidermoid carcinoma of the cervix. (Fig. 18.) Treatment was instituted and the patient was discharged in February, 1947.

CASE III. Mrs. M. G., white female aged seventy-eight, was seen in June, 1946 complaining of pain in the rectum. No history of vaginal bleeding or discharge was obtained. Pelvic examination was unsatisfactory due to a marked atrophic vaginitis. No cervical lesions were found. Cervical smears revealed adenocarcinoma of the fundus. (Fig. 19.) Under anesthesia a pyometra was found with a fundal malignancy infiltrating posteriorly to the pelvic wall. Tissue examination revealed adenocarcinoma of the fundus. (Fig. 20.) The case was classified as too advanced for any curative treatment.

CASE IV. Mrs. J. G., a white female aged fifty-three, was admitted to the hospital January, 1947 with a history of vaginal discharge since June, 1946 and vaginal bleeding since December, 1946. Pelvic examination revealed a granular-like ulceration on the anterior and posterior lips of the cervix. Examination of the parametria, adnexa and uterus was negative. A vaginal smear revealed squamous carcinoma of the cervix. (Fig. 21.) Biopsy revealed epi-
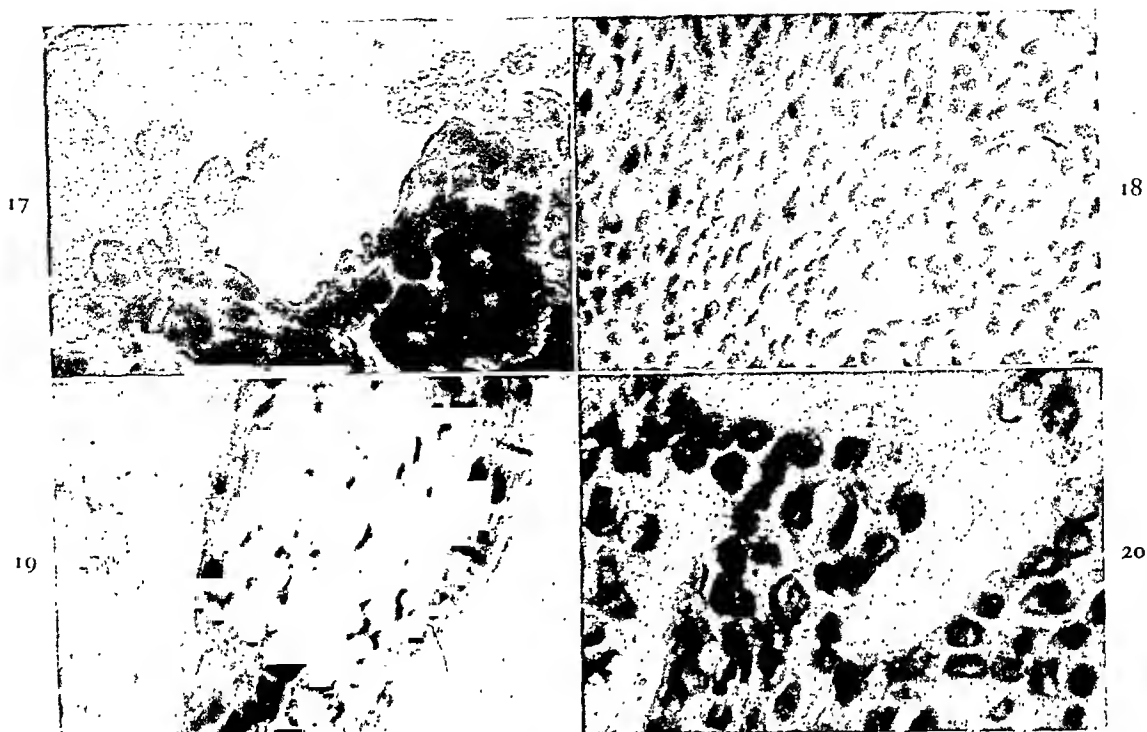
FIG. 17. Group of cells found in squamous carcinoma of cervix, stage one.
FIG. 18. Tissue section, squamous carcinoma of cervix.
FIG. 19. Group of cells found in adenocarcinoma of corpus.
FIG. 20. Tissue section, adenocarcinoma of corpus.
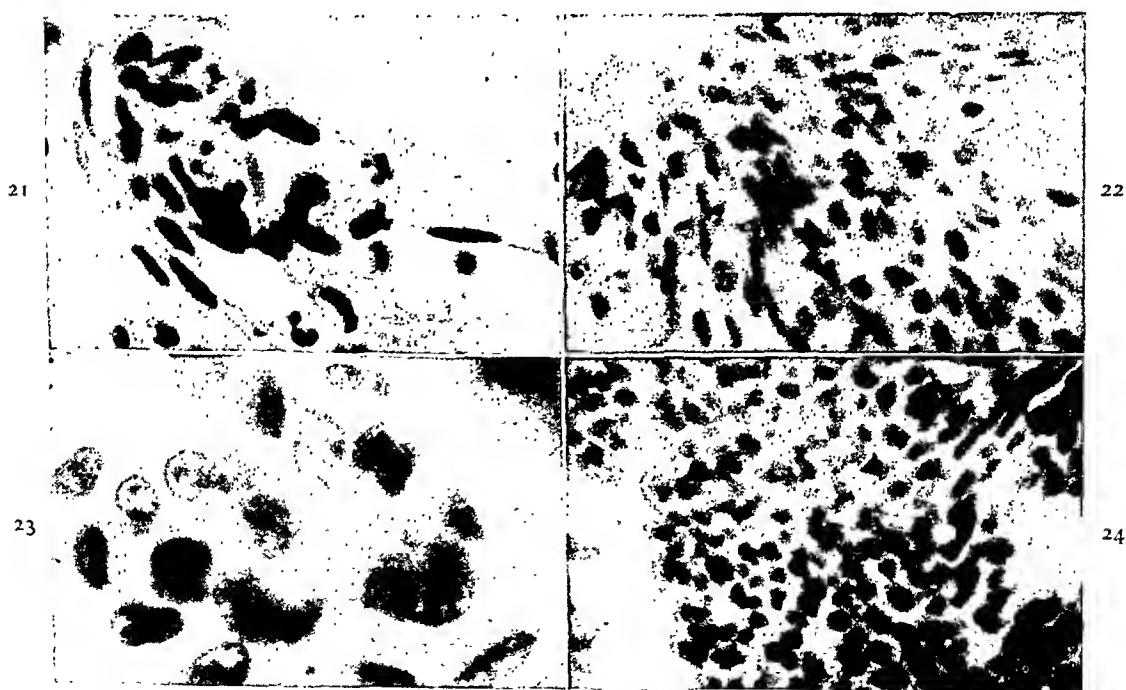
FIG. 21. Group of cells found in squamous carcinoma of cervix, stage one.
FIG. 22. Tissue section, squamous carcinoma of cervix.
FIG. 23. Group of cells found in squamous carcinoma of cervix (local recurrence).
FIG. 24. Tissue section, recurrent squamous carcinoma of cervix.

dermoid carcinoma of the cervix grade ii–iii. (Fig. 22.) Treatment was given and the patient was discharged in February, 1947.

CASE V. Mrs. E. R., a colored female aged forty-two, was treated for squamous carcinoma of the cervical stump, stage I, in 1945. In October, 1946 routine smears were taken in our follow-up clinic. A positive smear was found which we believed to be evidence of local recurrence. (Fig. 23.) Shortly afterward she began to bleed, and since then recurrence has been definitely established. A tissue section was taken. (Fig. 24.)

CASE VI. Mrs. P. V., aged sixty-seven, a diabetic and cardiac, suddenly developed a purulent discharge in May, 1947. She was seen in June, 1947. Pelvic examination was negative. The cervix was clean. Vaginal smears revealed a squamous carcinoma of the cervix. She was hospitalized, at which time multiple biopsies of the cervix were taken and a thorough curettage of the endometrium and cervix was performed. The biopsies of the cervix were reported to have no malignancy. In the curettements some cervical tissue was found to contain definite squamous carcinoma cells.

Advantages of Procedure. (1) Smears can be repeated frequently without subjecting the patient to repeated biopsy or curettage; (2) pre-invasive carcinomas can be diagnosed in grossly innocent appearing cervices; (3) local recurrences can be detected before clinical findings would be positive; (4) as a screening process it is the quickest and least expensive for the patient.

Disadvantages. (1) Staining technic is long and has not been completely perfected; (2) experience is necessary in cytology for proper interpretation of the smears.

CONCLUSION

Vaginal and cervical smears for the diagnosis of malignancy is the only known method today by which a very early diagnosis can be made. This method should be adopted as a routine procedure, and all hospitals and clinics dealing with gynecologic conditions should train gynecologists in the technic and interpretations of smears.

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HYPOTHERMIA IN HYPERTHYROIDISM*

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HYPOTHERMIA, or reduced body temperature, has a great number of effects on human physiology and many of these have been remarked and utilized in therapy since the earliest times. Local hypothermia was one of the very first forms of anesthesia; recently Allen in 1941 greatly extended its use in amputations and other surgery.

Thyroid surgeons are familiar with application of ice packs in the management of thyroid crises; then, of course, room temperature also becomes of vital importance postoperatively, especially on warm days when the hyperthyroid patient must be kept cool at all costs.

The effects of cold and of hypothermia are by no means simple in the case of the thyroid gland. In fact, it is to be emphasized, they are fascinatingly and suggestively complex. The consensus among investigators of the effects of hypothermia in animal experimentation in the thyroid gland is far more markedly affected by reduced temperatures than any other organ (Ariel and Warren, 1943). Ludford and Cramer (1928 to 29) observed congestion of the thyroid capillaries and increased secretory activity in epilated rats after twenty-four hours in an ice chest. Dietrich and Schweigk in 1932 recorded an immediate increase of the blood flow through the thyroids of chilled dogs. A review of the literature shows that there are many reports indicating the rôle played by various other organs in heat production and heat regulation, notably the adrenal glands, the pancreas and the brain.

Nevertheless, all this experimentation has served but to demonstrate the unique significance of thyroid response to hypothermia. The most careful and extensive studies have been made by Ariel and Warren (1943) who stressed the following findings: "Many factors may control the reactions of the temperature-regulating mechanism of the body; yet in our studies the thyroid presented the most profound histological changes. . . . In rabbits subjected to lowered body temperature (28 degrees to 10 degrees c. rectal temperature) for various periods, an acute profound physical and histological change has been noted consistently in the thyroid gland."

Before describing briefly the observations of these workers it will afford the correct perspective in relation to the basic significance of these determinations to point out that we are not concerned with a limited research nor an isolated study. The work of Ariel and Warren has been comprehensive, involving a lengthy series of investigations on the effects of hypothermia on every organ and tissue of the body. Further, the findings of others have been similar in the cases of all warm blooded animals studied. It may be regarded as an established fact that exposure to low temperatures results in stimulation of the thyroid gland as indicated histologically by increase in the height of the epithelium, vacuolization of the colloid and changes in the staining reaction of the colloid.

Ariel and Warren found that profound changes in the size of the follicular epithelium and changes in the follicular contents of the thyroid gland may occur rapidly in the various stages of artificial, general hypothermia. Marked changes may be observable within one-half hour after chilling of the body has been started. These may be extensive enough when combined

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with vascular engorgement to enlarge the thyroid gland in the gross from one and one-half to three times its normal size. As hypothermia is maintained the size of the follicular epithelium increases progressively, the number of vacuoles increases and the colloid rapidly diminishes. In the early stages of hypothermia there is a tremendous increase in the circulation, the thyroid blood vessels becoming engorged. Remarkably, as the temperature is allowed to return to normal, there is a rise in the metabolic rate to as much as 150 per cent above normal.

Continued hypothermia restricts the circulation and lessens the chemical activity and exchange, but the gland is gradually depleted of its colloid which is slowly replaced. After some twenty-four hours in the hypothermic state the animal may show no rise in the metabolic rate as the temperature is permitted to return to normal. After such prolonged hypothermia the acini are made up of large cuboidal cells and vacuoles. As might be expected although recovery is apparently complete after a brief period of moderate temperature reduction, hypothermia for more than twenty-four hours may result in death, especially when the body temperature has been reduced more than a few degrees.

The most striking finding was that within as brief a period as six to twelve hours (or even less) the thyroid gland in the hypothermic animal manifests acute hypertrophy—most of the follicles are devoid of colloid, the cells are cuboidal to low columnar in shape with sharply defined nuclei and the blood vessels are dilated and engorged, there being no evidence of edema. The gland is invariably much enlarged because of cellular hypertrophy (three to four times) and blood vessel congestion.

Such are the findings in the experimental animal subjected to a comparatively brief period of moderate, general hypothermia.

General hypothermia in human beings has been investigated in the hope that some benefit might be derived for cancer and a number of other conditions, but the results have been negative and the risks high, especially when the body temperature was allowed to fall more than a few degrees and remain at a low level (below 90°F.) for more than a few hours. The great risk has been shown to be shock associated with the rise in temperature immediately following the period of general hypothermia. In a number of instances to be found in the literature, however, the human subject has been reported to have recovered satisfactorily after the temperature had been reduced more than 15 degrees and maintained at a low level for one, two or even more days. Further, some favorable responses to *local* hypothermia in cases of superficial cancer have been recorded, there having been no adverse effects of the chilling which was accomplished by special coils or pads through which liquid at a low temperature was circulated for days or weeks.

As has not been suggested elsewhere to our knowledge the shock following a period of general hypothermia in the human being may apparently be explained by the findings of Ariel and Warren—that there is then a great rise in the metabolic rate as a result of the induced hyperactivity of the thyroid gland, provided the period of general hypothermia has not exceeded six to twelve hours and the thyroid has not been completely depleted of its colloid and hormone.

Because of the established knowledge of the great dangers associated with general hypothermia in the human being, no conservative physician or surgeon would now consider its use unless temperature reduction were just a few degrees and the period of reduction brief, with a very gradual return to normal temperature so as to avoid any risk of shock.

As for local hypothermia in hyperthyroidism this treatment is of established and great value, not only in a thyroid storm but also during the preoperative period to allay restlessness when an ice bag may be applied to the thyroid gland

and, if there is palpitation, over the heart. (The use of an air conditioned room to keep the patient cool does not, or should not, induce hypothermia; the purpose is to prevent a rise in temperature in warm weather when a crisis may threaten.)

Of course, local hypothermia has physiologic effects that differ greatly from those of general hypothermia in which condition a number of complicated mechanisms are called into play, the adrenal glands and other endocrines as well as the thyroid are affected in unknown ways and a vast number of complicated chemical and physiologic reactions undoubtedly occur. In the absence of studies on the effects of *prolonged local* hypothermia in which the temperature of the thyroid gland (with the exception of surrounding tissue) is reduced by several to many degrees by an ice bag or special cooling device (coil or pad) it is certainly worth while to inquire: may such a measure be expected to result in beneficial effects in hyperthyroidism?

It is pertinent that low temperatures (5 to 10°C.) have a "completely disastrous" effect on thyroid tissue in tissue culture (Carpenter, 1945). It is also suggestive that local hypothermia prolongs and increases the desirable effects of certain drugs, such as penicillin administered in the treatment of gonorrheal arthritis (Trumper and Thompson, 1946).

Propylthiouracil and related drugs have by no means solved the problem of hyperthyroidism; in fact, with the use of each drug, special new problems arise. Thus, such a drug must be administered over a lengthy period. It is possible that local hypothermia in combination with drug therapy may markedly reduce the period of treatment. Certainly theoretical considerations would lead us to expect benefit from such combined therapy.

Thyroid glands subjected to prolonged administration of an antithyroid drug undergo hyperplasia becoming at least somewhat enlarged, with follicles irregular in shape, scant colloid and columnar epithelium containing large nuclei and showing numerous mitoses. Such active proliferation of the epithelium is quite comparable to that occurring in cultures of embryonic thyroid tissue upon which the effects of hypothermia are marked. Moreover, hypothermia local as well as general has its own peculiar effects on the thyroid gland and may be expected to act synergistically with propylthiouracil or a related drug thus enhancing its effects. No deleterious side effects are to be expected from local hypothermia when temperature reduction is moderate

SUMMARY AND CONCLUSIONS

The thyroid gland is markedly affected by exposure to cold. In general hypothermia the gland manifests acute hypertrophy, with increase in size of the epithelium and loss of colloid which may also undergo changes in staining reaction. Local hypothermia has long been used to advantage in the management of thyroid crises. Prolonged local hypothermia may be expected to have special effects on the physiology and histology of the hyperthyroid gland and may presumably act synergistically with propylthiouracil or a related drug in the therapy of hyperthyroidism.

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MISSED ABORTION*

AN EVALUATION OF CONSERVATIVE MANAGEMENT

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IN 1943 the authors[1] reported a series of eighteen cases of "missed abortion," the patients being treated by non-surgical measures, with a successful outcome. To date we have observed a total of thirty-nine patients with missed abortion without a maternal death and are presenting our findings and mode of management.

When a fetus dies *in utero*, it is commonly observed that uterine contractions begin within a comparatively short period of time and the uterine contents are expelled. However, there exists a group of cases in which for some as yet questionable reason this process fails to set in and the uterine contents are retained for varying lengths of time, sometimes weeks or months.

Our definition of missed abortion applies when the non-viable fetus succumbs and is retained for a minimum of four weeks. This is differentiated from the term "missed labor" which indicates fetal death at term with retention for at least twenty-eight days and "missed premature labor" indicating fetal death between the twenty-eighth and fortieth week, with a minimum period of retention *in utero*.

The exact incidence of missed abortion, which was first described by Duncan in 1878,[2] is not known. In addition the mode of treatment is by no means universally agreed upon. Many textbooks advocate immediate surgical evacuation of the uterus as soon as the diagnosis is made. The reasons given for the immediate emptying of the uterus which contains a dead fetus are toxemia, infection and hemorrhage. More recently, however, the employment of hormones to favor emptying of the uterus has been advocated.[3]

The signs, symptoms, diagnosis and pathology of missed abortion can be found in standard textbooks. We believe the mode of treatment, once the diagnosis is established, is worthy of presentation.

CLINICAL DATA

The ages of the patients varied between seventeen and forty-six years.

Age	No. of Patients
Under 20	1
21–30	17
31–40	15
41–46	6

The gravidity varied between one and thirteen. The total included eight primigravida and thirty-one multigravida, the latter divided as follows: two pregnancies, six; three pregnancies, seven; four pregnancies, four and from five to thirteen pregnancies, fourteen. One patient had one previous missed abortion and one had two previous missed abortions. One patient had a previous erythroblastotic baby. Thirteen patients had previous abortions, an incidence of 33.28 per cent. Seven patients had previous stillbirths, or an incidence of 17.9 per cent. (Fig. 1.)

Retention varied from four to twenty-eight weeks. Twenty-five, or 64 per cent, were retained from four to twelve weeks; two were retained from twelve to fourteen weeks; two for fourteen weeks; six were retained for seventeen to twenty weeks and six were retained for twenty-three to twenty-eight weeks.

It is to be noted that in keeping with our previous findings the period of retention

generally varied inversely with the age at which death of the fetus occurred. When fetal death took place early in pregnancy, the period of retention was longer than when it occurred later in pregnancy.

The signs and symptoms encountered were brownish vaginal discharge, cessation of fetal movements or failure to experience fetal activity and slight vaginal bleeding. Chilliness and anorexia were encountered in one case. Three cases were associated with syphilis and three with chronic nephritis. An elevated blood pressure, 140/90 or over, was found in eleven cases, or 28 per cent. Foul taste, mental symptoms and vomiting were not observed.

The commonest clinical findings were a smaller sized uterus than the chronologic period of amenorrhea would indicate, absent fetal heart sounds, cessation of fetal movements or failure to experience fetal movements as well as failure to gain weight with apparently advancing pregnancy. The cervix was found to be firm and closed in numerous instances and the uterus seemed to have a doughy sensation with absence of normal tonus.

The laboratory data indicated that anemia was a rather infrequent finding. The RH factor was recorded in ten instances, being positive in nine and negative in one. This one negative Rh resulted in an erythroblastotic infant.

Roentgenologic examination was employed in eighteen cases; eight indicated fetal death, one was questionable and the remainder were negative. The diagnostic criteria were, for the most part, relaxation of the fetal skeleton, collapse of the skull bones or over-riding of the bones. In the majority of cases the findings were not conclusive.

The Friedman modification of the Aschheim-Zondek test was not conclusive either, except when it was negative; of twenty tests performed, thirteen were negative and seven positive. Pathologic examination of the products of gestation was recorded in eleven instances and in only two was inflammation of the decidua noted.

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MANAGEMENT

In thirty-two patients, or 82 per cent, the fetus and placenta were expelled completely and no interference was necessary. In the remaining seven or 17.9 per cent, although the onset of the expulsive process
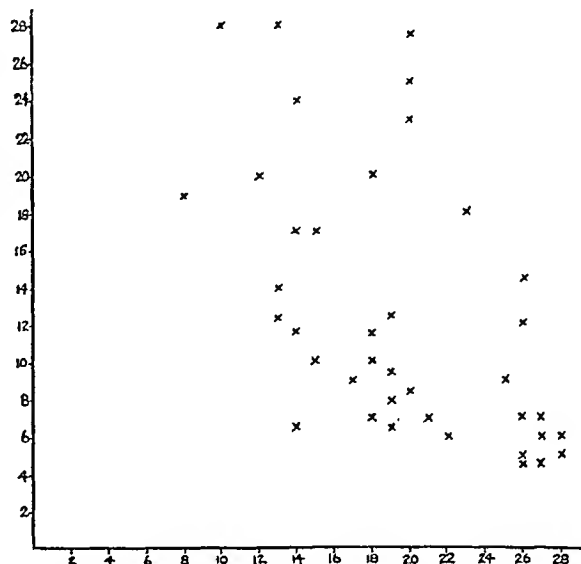
Fig. 1. The figures on the ordinate represent retention in weeks; those on the abscissa represent time of death in weeks.

was spontaneous in all, some assistance was necessary for the completion of the abortion. Five patients required manual removal of the retained placenta; of these one had a previous cesarean section for cephalopelvic disproportion. One patient required a sponge stick removal of retained secundines after rupture of the membranes and passage of some of the gestational contents. Another patient had spontaneous pain and vaginal bleeding with an undilated cervix. A firm vaginal pack was inserted for two hours. Upon removal of the packing in the operating room the fetus and placenta followed directly.

In all, six patients were given stilbestrol or estrogenic hormone therapy to stimulate the spontaneous expulsion of the retained ovum.

CASE REPORTS

CASE I. A patient with a fourteen weeks gestation which had been retained for seventeen weeks, after episodes of vaginal bleeding

associated with abdominal cramps, was given stilbestrol, 1 mg., daily for four days. The cramps increased and the patient ruptured her membranes while attending the prenatal clinic. Because of vaginal bleeding, immediate removal of the placenta was necessary.

CASE II. A patient with a thirteen weeks' gestation retained twenty-eight weeks complained of a brownish vaginal discharge. One mg. of stilbestrol was given orally for five days. Seventy-two hours after the last dose of medication the fetus and placenta were spontaneously expelled intact. It is difficult to understand such a remarkable effect from small doses of stilbestrol and coincidence must, therefore, be regarded as the element involved in the expulsion of these feti.

CASE III. A thirty-eight year old gravida 10, para 6, with a twenty weeks' gestation retained for twenty-one weeks, was admitted from the clinic, asymptomatic, for attempted trial of hormonal stimulation for completing the missed abortion. Roentgenologic examination confirmed the evidence of fetal death. Prior to admission the patient was given a trial of stilbestrol, 5 mg. orally three times a day for one week, without any results. After admission stilbestrol was administered orally, 3 mg. every three hours during the day for five days, followed by pituitrin, minims 5, every thirty minutes for a total of 4 cc. No uterine contractions or bleeding resulted. Stilbestrol in the same dosage was continued for the next five days, after which the patient signed a release. About two weeks later at home she spontaneously delivered a macerated fetus and placenta before her physician arrived.

CASE IV. A thirty year old para O, with a twenty-six weeks' gestation retained for ten weeks and hypertensive cardiovascular disease, was given 5 mg. of stilbestrol three times a day for eight days in an attempt to empty the uterus. Neither uterine contractions nor bleeding ensued and the patient signed a release. Two weeks later she returned in the process of actively aborting and passed a macerated fetus and placenta.

CASE V. A twenty-five year old para O, with a nineteen weeks' gestation retained for nine weeks, was seen in consultation for painless bleeding in the last trimester of pregnancy. Examination revealed a missed abortion with the uterus enlarged to ten weeks size and the cervix firm and closed. The Aschheim-Zondek test was negative. After three days without pain but with slight vaginal bleeding 45 mg. of stilbestrol were given orally in divided doses over a two-day period and the following day the fetus and placenta were extruded spontaneously.

CASE VI. A thirty-two year old para 8, with a thirteen weeks' gestation retained for twelve weeks, was admitted for vaginal bleeding. After four days of observation with slight vaginal bleeding ethinyl estradiol, .3 mg., was given three times a day for five days, followed by pituitrin in 3 to 5 minim doses for a total of 3 cc. Following the last injection, the patient developed uterine contractions and abdominal cramps with slight vaginal spotting. The next day ethinyl estradiol, .3 mg., was given again three times a day for three doses, followed by 3 cc. of pituitrin in divided doses of 5 minims every twenty minutes. Four hours after the last injection the patient experienced uterine cramps and passed a large blood clot, but examination revealed the cervix to be closed with the uterus sensitive to palpation and undergoing intermittent contractions. Two days later the patient spontaneously expelled a stillborn fetus and manual removal of the placenta was necessary because of excessive bleeding. This patient required a blood transfusion.

Of the thirty-nine reported cases, twenty-seven patients were observed at the Cumberland Hospital and the abortions occurred between November, 1934 and November, 1946. The remaining twelve patients were seen at other hospitals and the authors participated in the management, consultation or observation of these cases.

The length of the active aborting process was recorded in twenty-one cases and ranged from three hours and fifteen minutes to forty-eight hours, the average being about eleven hours. In only six patients, did the abortive period last longer than eleven hours. The blood loss was not excessive except in one instance in which following spontaneous expulsion of the fetus, manual removal of the placenta was necessary

Using the American College of Surgeons,

standard, only one patient in the thirty-nine, or 2.56 per cent, showed any morbidity. This patient required manual removal of the placenta following expulsion of a dead fetus which had been retained for thirty-four days. There were no maternal deaths in this series of thirty-nine cases. The average hospital stay postabortal, or postoperative, was 8.2 days, the shortest being five days and the longest thirteen days.

COMMENT

Many authors advocate surgical procedures in evacuation of the uterus in cases of missed abortion as soon as the diagnosis is made. They recommend this to combat the dangers of toxemia, infection and hemorrhage.

Surgery involves the dangers of hemorrhage, perforation and infection. Yet this method of treating missed abortion is relatively popular and was recently advocated in the Journal of the American Medical Association.[4]

Theoretically, surgical evacuation of the uterus in cases of missed abortion appears to be physiologically unsound. The hard, closed cervix .encountered in many of these patients does not lend itself readily to dilatation as does the normal pregnant cervix. In addition the uterine wall is usually thin and readily perforated, and the musculature is not responsive to the oxytocic drugs, such as quinine, ergot or pituitrin. Therefore, the physiologic requirements which are necessary to expel the products of conception in missed abortion are evidently lacking. In view of this it would seem unjustifiable to attempt interference by a method which is incompatible with the existing altered physiology.

Through the courtesy of Dr. Charles A. Gordon, Chairman of the Committee on Maternal Welfare of the Kings County Medical Society, we are presenting abstracts of all the case histories of those with missed abortion (three in number) who have died in Brooklyn during the past ten years:

CASE I. A thirty-nine year old white female, para 4, was admitted to the hospital with a history of five months' amenorrhea and a uterus which was three months' size. The Aschheim-Zondek test was negative. A soft rubber catheter was inserted into the uterus and a pack into the vagina. Both catheter and pack were removed after twenty-four hours and the vagina was repacked. Chills and fever followed and persisted for three weeks. Penicillin and sulfanilamide therapy were employed. The diagnosis was pelvic peritonitis and parametritis. Three weeks after the initial packing the products of conception were spontaneously expelled. Four days after leaving the hospital the patient noticed rectal bleeding which continued on and off. She was re-admitted to the hospital and given a transfusion. A laparotomy was performed and at operation a loop of small intestine and the rectosigmoid were found densely adherent to the fundus and posterior surface of the uterus. Many adhesions were freed and an ulcer of the rectosigmoid, 1 inch in diameter, was found at the adherent surface. Profuse bleeding from the edges of the ulcer followed. The proximal loop was pulled out and a Mikulicz spur was made. The patient expired from shock and further uncontrollable hemorrhage three hours postoperatively.

CASE II. A thirty-two year old white female, gravida 2, para 1, was admitted to the hospital with a missed abortion and a uterus the size of a four months' gestation. Because of vaginal staining, medical induction was attempted but without success. Following this, a vaginal hysterotomy was done under spinal anesthesia. The postoperative bleeding was excessive and the vagina and cervix were packed. Supportive therapy and attempted transfusion were not effective and the patient expired.

CASE III. A twenty-five year old white, gravida 3, para 2, was admitted to the hospital with a four months' missed abortion. The fetus was dead about three months. Cervical dilatation and rupture of the membranes was performed to evacuate the uterine contents. Hemorrhage followed and the uterus and vagina were packed. A vaginal hysterotomy was done under intravenous evipal anesthesia. Transfusion and supportive therapy were employed, but the patient succumbed. Death was

thought to be due to hemorrhage, toxic hepatitis and secondary anemia.

It is interesting to note that the only deaths from missed abortion in Brooklyn during the past ten years resulted when surgical interference was instituted.

In a series of 200 patients, in which death of the fetus was produced by x-ray as a means of interrupting pregnancy for various indications, experimentally-produced missed abortions resulted.[5] In this series the toxic symptoms and indications for surgery were not prominent.

Several years ago Frank et al.[6] observed that when a fetus succumbed *in utero* the blood estrin titer fell to low levels and that this test was more sensitive as an indicator of fetal death than the Aschheim-Zondek test. That the functioning placenta rather than the fetus is the determining factor in both of these tests has been shown by Polonsky[7] and Jeffcoate.

With the low estrin findings in many cases of missed abortion, an attempt was made[3] to duplicate nature's supposed method of inducing labor by administering estrogens, either natural or synthetic, or stilbestrol followed by pituitrin. Yet even in the largest series reported, about one-third of the patients failed to respond to hormonal induction of uterine evacuation. This hormonal method of induction of labor is not harmful and we believe it may be attempted without fear. We have in several instances admitted patients to the hospital for study and possible hormonal attempts at induction and much to our astonishment have found that they aborted spontaneously while waiting for laboratory studies to be completed. That this may occur was also noted by Jeffcoate who advocates hormonal induction of expulsion. In addition some patients abort so soon after the first few doses of hormone are administered that the factor of chance and coincidence must be seriously taken into consideration.

Many patients with missed abortion are admitted with premonitory signs of expulsion of the products of gestation, i.e., either bleeding, or uterine pain or both. Therefore, successful results obtained in these patients with estrogenic hormone and pituitrin may be more apparent than real. One should, therefore, be extremely cautious in evaluating the efficacy of this form of therapy, especially when used in the type of patient just cited.

SUMMARY

1. A series of thirty-nine cases of missed abortion is presented in which a non-viable dead fetus was retained for at least twenty-eight days.

2. Surgical evacuation of the retained ovum was not attempted in any patient in this series.

3. Only seven patients required any assistance toward completion of the active aborting process.

4. There was no maternal mortality and in only one case was there any morbidity.

5. The only deaths from missed abortion in Brooklyn during the past ten years resulted when surgical interference was instituted.

6. Laboratory data indicative of fetal death are not entirely reliable except when the Aschheim-Zondek test is negative and roentgenologic study indicates positive evidence of death of the fetus.

7. Surgical and hormonal induction of labor are discussed, together with the pertinent pathologic conditions.

CONCLUSIONS

The difficulties which are encountered in surgical evacuation of the uterus containing a dead ovum, namely, hemorrhage, infection, perforation and forcible tearing of an undilated, rigid cervix, can be averted by not resorting to untimely interference from below. We have not encountered any of these conditions except mild bleeding at the onset or during the process of expulsion.

Awaiting the spontaneous expulsion of the dead ovum appears to be indicated since at that time the normal uterine tonus is restored and normal uterine contractions,

either alone or with the aid of oxytocic drugs, prevent excessive bleeding.

Hormonal stimulation to evacuate the retained ovum may be attempted without danger.

From this study of missed abortion the authors believe that a waiting policy is not only justified, but can be considered clearly indicated.

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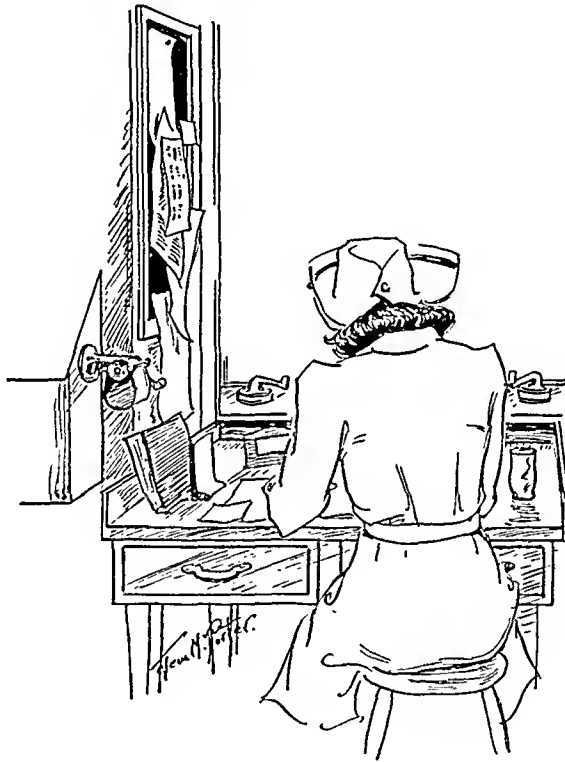
TREATMENT OF LARGE BOWEL FISTULA SECONDARY TO WAR WOUNDS

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THE basis of this report was our experience in the surgical reconstruction of the continuity of the large bowel in twenty-five soldiers suffering from the sequelae of large bowel wounds. These men were treated by the authors at an Army General Hospital in the European Theater of Operations.

PROBLEMS IN RECONSTRUCTING BOWEL CONTINUITY

In the European Theater of Operations the incidence of abdominal wounds was slightly over 3 per cent.[1,2] The marked reduction in mortality of wounds of the colon between World War I and World War II can be explained by several factors, the most important of which we believe to be the policy of exteriorization of wounds of the colon or the performance of surgical repair of the damaged bowel and proximal colostomy in wounds of the ano-rectal canal and lower sigmoid. Of great importance, too, in the reduction of mortality was the army policy of placing competent surgical teams in forward positions thus decreasing the time interval between injury and definitive surgical treatment. Use of large amounts of blood and plasma and the development of chemotherapy and antibiotics also share in the reduction of mortality. (Tables I and III.)

The problem of re-establishing the continuity of the bowel in these patients was vastly different from the same problem found in civilian life because of associated battle injuries (Table II) and because little or no information was available as to what was found or done at the initial procedure. This point has been emphasized time and time again by military surgeons.[4,6,8]

The colostomies seen by us appeared to be the same type seen in civilian life, namely, loop or double-barrelled colostomies of the Mikulicz type. Subsequent experience, however, proved that they were "booby trapped" and fraught with peril for the patient. One has to remember

TABLE I
LARGE INTESTINE WOUNDS
Ascending colon	6
Transverse colon	3
Descending colon	4
Sigmoid colon	3
Rectum	9

TABLE II
ASSOCIATED INJURIES
Stomach	1
Small intestine	5
Bladder	4
Spleen	2
Kidney	1
Lung	3
Peripheral nerve	1
Compound fracture	4
Soft tissue	25

TABLE III
LOCATION AND TYPE OF OPERATIVE FISTULA
Cecostomy	5
Loop colostomy	6
Ascending colon	2
Descending colon	4
Double-barrelled colostomy	14
Transverse colon	3
Descending colon	5
Sigmoid colon	6

that colostomies for war wounds were often done in haste. They were done most frequently at the site of injury (Table I) and not at the point of election as seen in civilian life. The military surgeon consequently was committed to closing a colostomy about which he knew little and which was often defective or unorthodox in construction. The problems encountered in our series were angulation of limbs and/or rotation of limbs of the colostomy; bowel or mesentery between the limbs of the

colostomy; prolapse of bowel lateral to the colostomy due to failure to close the lateral gutter and fistulas or inflammatory masses involving the colostomy.

CRUSHING OF SPUR AND INVERSION VS. RESECTION AND END-TO-END ANASTOMOSIS

All of our colostomies were carefully evaluated by digital examination under pentothal anesthesia. No crushing clamps were applied until examination under anesthesia revealed the exact length of the spur and the absence of tissue between the limbs of the colon. Clamps were not applied if any doubt existed. We deemed it safer to expose the bowel completely in these cases and do a resection with end-to-end anastomosis if necessary. No attempt was made to confine closure procedures to the extraperitoneal level.

In general the patients who had crushing clamps applied complained of some discomfort and occasionally of nausea for the first few hours. No sedation was given and all patients were watched closely for signs of any intra-abdominal catastrophe. It required repeated application of clamps in practically all cases before the spur was adequately broken down.

Horsley and Michaux[5] state that one of the advantages of a loop colostomy was the lack of a spur. Of the six loop colostomies in our series four had definite spurs. We had no further information on these patients other than a note that a loop colostomy had been done. We believe that no matter how they were made originally most loop colostomies which have been present for several weeks develop some spur. In all of our patients a minimum of seventeen to twenty-one days had elapsed after their initial surgery before we received them. Attempts to crush the spurs present in ten double-barrelled and four loop colostomies were successful in seven of the former and three of the latter.

We believed that it was safer to do a resection and end-to-end anastomosis rather than blind crushing of the spur. Subse-

quent operation revealed the previously listed defects in the original construction of the colostomy. We do not concur with those who stress the dangers of resection and end-to-end anastomosis in this type of case. The patients were all young and in

TABLE IV
METHOD OF CLOSURE OF COLOSTOMY

1. Loop Colostomies................................ 6
      Crushing of spur and inversion............... 3
      Resection and end-to-end anastomosis........ 3
2. Double-barrelled Colostomies.............. 14
      Crushing of spur and inversion............... 7
      Resection and end-to-end anastomosis........ 7
3. Cecostomies............................... 5
      Inversion...................................... 5

good physical condition before operation was attempted. Extensive resections were not necessary; hence, there was never any tension on the suture line. The peritoneum was usually well walled-off; consequently, when the peritoneal cavity was entered, it was a localized pocket of peritoneum rather than the free peritoneal cavity. All of the resections were in the left half of the colon; no resections were done on the right half of the colon. None of these anastomoses were done by the so-called aseptic technic since it was thought that this procedure was not indicated in the presence of an open colonic stoma. All abdominal wounds were drained subcutaneously for forty-eight hours. There were seven double-barrelled and three loop colostomies that were resected and end-to-end anastomosis done. (Table IV.)

Pre- and Postoperative Care. All colostomies were closed before the patients were returned either to duty or to the Zone of Interior, unless some major contraindication existed. As much time as was necessary was taken to get patients in good general condition before any operative procedures were undertaken. No preoperative chemotherapy was used since neither sulfaguanidine or sulfasuxidine was available to us. Patients were placed on low residue diets several days prior to operation. Proximal, distal and retrograde (rectal) irrigations were done daily for at least a week preoperatively. The night before operation

a Miller-Abbott tube was passed into the small intestine. Postoperatively the bulb of the Miller-Abbott tube was inflated and the patient maintained on Wangensteen decompression until flatus was passed which was usually within twenty-four to seventy-two hours. The Miller-Abbott tube was then removed. One unit of plasma was given empirically each day for the first three days as well as 30,000 units of penicillin every three hours. By the fifth day the patient was on a soft diet and was usually having normal bowel movements; by the tenth day he was out of bed and on the fourteenth day he was eating in the mess hall.

TECHNICS

Inversion. Bowel continuity was re-established following adequate crushing of the spur and subsiding of edema in the following manner: The stoma was encircled leaving a cuff of skin. Allis clamps were used to close the stoma temporarily. The bowel was then freed from the subcutaneous tissue and fascia. The fascia was opened freely above and below and the limbs of the colostomy separated sufficiently to allow placement of the closed stoma below the fascia. The peritoneum was opened as much as was necessary to allow adequate mobilization. The cuff of skin and indurated bowel edges were then excised and the bowel closed transversely with an inner layer of continuous catgut Connell suture and an outer layer of interrupted silk Halstead mattress sutures. The fascia was closed with interrupted cotton sutures. The subcutaneous tissue was drained with a rubber dam (forty-eight hours) and the skin was closed with interrupted cotton sutures.

Resection. In cases of resection the stoma was freed as previously stated. The peritoneum was opened freely to obtain adequate mobilization of the limbs of the colostomy without tension on the suture line and to correct any defect found. The amount of bowel and mesentery resected was usually small. End-to-end anastomosis

was done with seroserous interrupted Halstead mattress sutures of fine silk and a through-and-through layer of continuous Connell catgut suture. A purse-string suture was placed at each angle. An appendix epiploica was sutured over each

TABLE V
POSTOPERATIVE COMPLICATIONS

Cases Inverted..............................	15
Intestinal obstruction......... 1 (small intestine)	
Minor wound infection........ 5	
Pelvic abscess............... 1	
Fecal fistula (temporary)...... 2	
Incisional hernia............. 1	
Cases Resected..............................	10
Intestinal obstruction......... 1 (small intestine)	
Minor wound infection........ 1	

angle. A purse-string suture was also placed from the lateral bowel wall to the parietal peritoneum to close the lateral gutter in all cases in which the peritoneum was opened.

Postoperative Complications. The postoperative complications are summarized in Table v. The incidence of postoperative complications was much less in the resected group. The two cases of intestinal obstruction encountered postoperatively were in the small bowel. They were due to adhesive bands resulting from the initial abdominal injury and were not related to the type of procedure done at the closure of the colostomy. There was a high incidence of wound infection postperatively in the inversion closure group. However, all were minor infections of the subcutaneous tissues and none involved the deeper structures. None of the infections prolonged convalescence or became of major significance. The two fecal fistulas were minor and both closed spontaneously within two weeks. An incisional hernia developed in a man who had inversion closure. This patient had extensive loss of tissue of the abdominal wall. No attempt was made to do any repair of the abdominal wall at the time of closure of his colostomy. The pelvic abscess was drained intraperitoneally and the patient made a good recovery. The abscess was undoubtedly due to a technical error with leakage at the suture line.

Results. There was no mortality, and clinically all of our patients were asymptomatic at the time of discharge or transfer which was four to six weeks postoperatively. Barium enemas were obtained on ten patients; four on the resected with end-to-end anastomosis group and six on the inversion closure group which included one cecostomy.

In a recent article Sanders and Halperin[4] have found some degree of constriction in cases in which the colostomy was resected and end-to-end anastomosis done. In four barium enemas done postoperatively on our series of resected cases we found evidence of constriction of the bowel lumen at the operative site in three cases. Clinically all our patients were asymptomatic despite X-ray evidence of constriction. We are attempting to get a two to three year follow-up on our series which will be reported later. Because of the high incidence of positive X-ray evidence of some degree of constriction in resected colostomy patients, Sanders and Halperin recommend the Pauchet technic in colostomy closure. We believe that this technic has a definite place but we have had no experience in its use. Our results are in accord with recent reports by Hamilton and Cattanach[6] and Roettig, et al.[9] However, Gregg and Moseley[10] believe that resection with end-to-end anastomosis would carry a higher morbidity and mortality than inversion closure.

SUMMARY AND CONCLUSIONS

1. A report of the closure of fourteen double-barrelled colostomies, six loop colostomies and five cecostomies secondary to war wounds is presented.

2. The dangers in crushing the spur of war time colostomies are emphasized.

3. The type of procedure carried out in re-establishing the bowel continuity varied with the individual case.

4. The results at the end of four to six weeks postoperatively of simple inversion of the colostomy after crushing of the spur (ten cases) and of resection with end-to-end anastomosis (ten cases) are presented. There was no mortality and all patients were clinically asymptomatic.

5. Resection with end-to-end anastomosis offered fewer postoperative complications than inversion closure after adequate crushing of the spur. However, the resected group showed a higher incidence of constriction of the bowel lumen on postoperative X-ray studies.

6. In our experience, contrary to that of some other observers, resection with end-to-end anastomosis did not carry a higher risk of mortality or morbidity than extraperitoneal closure by inversion.

7. The treatment of wounds of the large bowel in civilian surgery should be carried out according to the principles used in the army, i.e., exteriorization and subsequent closure.

8. A two to three year follow-up on this series of cases is being carried out and will be reported at a later date.

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DIVERTICULUM AND ABSCESS OF THE FEMALE URETHRA

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MANY names have been given to the condition of diverticulum and abscess of the female urethra. The terms diverticulum, urethrocele, urethral abscess and urethral pouch are synonomous in the literature. This is a condition that is very often overlooked by the general practitioner. However, every large general surgical service sees it often enough to keep it in mind.

The number of cases one sees is necessarily small unless he has the privilege of working in a large general hospital such as Harlem Hospital. No physician can truly understand this disease unless he understands both the pathology and the anatomy of the lower urinary tract.

In the male there are two portions a lower proximal part of less than 1 inch in length extending from the bladder to points where the ducts of the reproductive glands join the canal; and the much longer distal portion which serves as a common passage for the secretions of the kidneys and for the generative products.

The female has a urethra that is a great deal simpler in its arrangement. The female urinary passage represents only the proximal portion of the male canal. It is short, 1½ inches in length, is slightly curved down and forward and leads to the external meatus. The posterior wall of the urethra, except in its upper portion, is intimately related with the anterior wall of the vagina. Here one can readily see that trauma and infection can cause injury to the urethra. The mucous lining is raised in folds; one that is more distinct than the others and is placed on the posterior wall is called the crista urethralis.

The wall of the female urethra is thick and contains much fibrous tissue which passes without demarcation into the surrounding mass of connective tissue. The tunica muscularis is continuous with that of the bladder and is composed of longitudinal and circular smooth muscle. The muscular coat within is very vascular. The epithelium in its upper portion has cells of the transitional variety while the lower part is squamous in character. Minute glands, the glandulae urethralis, and the pit-like depressions, lacunae urethralis, open into the urethra. One group of glands on each side opens by a common duct on each side of the urethral orifice. These are the para-urethral glands and are similar to the prostatic glands.

To describe briefly the male urethra, it is 8 inches long. As it goes from the internal urethral orifice to the external urethra, it describes a double curve. The urethra is divided into the prostatic portion which lies in the prostate, the membranous portion which pierces the pelvic wall and the cavernous portion surrounded by the corpus cavernosum. The membranous portion is the shortest and the cavernous portion is the longest.

The mucous membrane contains numerous elastic fibers and it varies in thickness. The lining is composed of many cells. In the fossa navicular is it is squamous but in the cavernous portion, which is the longest, it is columnar. Numerous glands open into the urethra. These are numerous on the anterior wall, in the anterior portion of the cavernous region and in the membranous portion of the urethra. The longer glands are beneath the mucous membranes, connected with it by means of long, slender ducts. The muscular wall of the upper urethra has smooth muscle, mostly longitudinal with a few circular fibers, but in the greatest portion of the cavernous urethra there is no circular coat.

Thus, in recapitulation we see that the female urethra is shorter, straight, not

curved, is a passage for the urinary secretion only and has more fibrous and muscular tissue. The stroma of the mucosa is of the transitional and squamous variety.

REVIEW OF THE LITERATURE AND PATHOGENESIS

According to Johnson[1] most diverticula are congenital in origin. Their points of genesis are Gartner's ducts. His opinion is that they arise by faulty union of primal cell rests, Wolffian duct or vaginal wall cysts.

Most authors such as Huddy,[2] Cabot and Shoemaker[3] show in their work that there are no glands in the posterior two-thirds of the urethra and that the vast majority of diverticula and abscesses are due to trauma and infection. This point of view is also upheld by Schmitz and Nelson.[4]

Furniss[5] in his classical article on diverticula and abscess believes that the glands of the floor are involved in both specific and non-specific cases. Most of the time the infection drains into the urethra and the infection clears up. Since the external meatus is the least distensible portion of the lower urinary tract, the diverticulum increases in size due to back pressure. In many cases the abscess precedes the diverticulum. This ruptures into the urethra or into the vagina. If the abscess is incised near the internal sphincter, a fistula results. Therefore, Furniss comes to the conclusion that whenever a diverticulum is repaired, a meatotomy should be done concomitantly.

Engel[6] finds that most of his cases were in women past thirty years of age. Also he is of the opinion that the evidence is in favor of a cyst which later ruptured into the urethra and thus established a communication.

Higgins[7] reports the formation of a calculus in a diverticulum due to infection, stasis and absence of drainage.

Menville and Mitchell[8] found only thirteen cases out of 10,585 admissions. From this number of patients they found that ten were negroes and three were white.

At the Harlem Hospital between the years of 1938 and 1946 fifteen cases of suburethral abscess and diverticula were found. Of the patients, ten were negroes and five were white. Their ages ranged between twenty-seven and sixty years of age; 67 per cent of the patients ranged between twenty and forty years of age. Of these patients six had concommitant symptoms of pelvic inflammatory disease in one form or another. Two patients gave no history of pelvic infection but gave a history of trauma to the vaginal vault. One patient developed a urethral abscess following a marked cystitis and trigonitis. This case may illustrate very well Furniss' point of lack of drainage due to a small, external meatus. The latter fact was not noted on the chart. In those patients past forty the diverticula accompanied a cystocele, the result of multiple pregnancies.

Symptoms in order of complaint were: frequency; lump or mass in the urethra; burning on urination; pain on urination; dribbling and pain in the back; and hematuria.

All these cases were diagnosed clinically at first. Attention was focussed on the urethra by the patient herself, especially in those instances in which an abscess, cyst or induration was present along the urethra.

TREATMENT

Medical. Methods of treatment used were dilatation and the instillation of argyrol 10 or 15 per cent. This follows the precept of Furniss of dilating the external meatus and allowing adequate drainage. All patients were treated as aforementioned except the last. Three patients experienced a rupture into the urethra while being instrumented. One patient was treated with 30,000 units of penicillin every three hours in addition to the aforementioned therapy.

Surgical. One patient was repaired surgically. This was done by a midline

tive arthritic, and localized along the patello-femoral surface, suggesting that the osteo-arthritic changes are caused by friction of the patellar tendon against this region of the condyles."

ANATOMY

The work of Brooke and the anatomic studies of Whitnall of Bristol University helped to clarify the functional and physical relationship of the patella to the quadriceps tendon. A clear understanding of the anatomy involved is perhaps the most important factor in deciding on the type of treatment to follow.

The quadriceps femoris muscle consists proximally of four distinct muscles, the rectus femoris, vastus medialis, vastus lateralis and vastus intermedius. These four muscle groups converge distally to form the quadriceps tendon which passes over the patella, which itself is closely attached to the under surface of the quadriceps tendon but is not a true part of it. Laterally and medially the quadriceps tendon extends as the lateral and medial patellar retinaculae or, more simply, as the lateral and medial tendinous expansions which pass downward to insert into the margins of the tibial condyle. The central portion of the quadriceps tendon continues over the patella, distal to which it continues as the patellar tendon, inserting into the tibial tuberosity.

This extraneous relationship of the patella to the quadriceps tendon explains why removal of the patella does not *per se* weaken the extensor function of the quadriceps. It makes clear why repair of the tendinous expansion remains of primary importance in restoring the power of extension and why repair or removal of the patella is of secondary value. Treatment should be guided by the attempt to obtain an end result in which extension is unweakened and joint surfaces are smooth. All cases of fracture of the patella do not require open repair, but all cases in which the tendinous expansions are torn do require this repair if we are to secure a stable, strong knee, just as an important tendon elsewhere needs to be repaired when torn. The only question to be kept in mind in respect to the patella itself is whether or not the articular surface of the patella remains in smooth apposition to the cartilaginous surface of the femoral condyles.

TREATMENT

During the past four years we have treated 110 cases of patellar fractures. These cases have been carefully reviewed and we believe that from our study of these cases we can now draw several reliable conclusions; moreover, we believe that our present method of treatment can be expected to give good end results and leave the patient with a strong, stable knee, in most cases having completely normal appearance and function.

We do not agree with the opinion as expressed by some authors that all open reductions should have complete patellectomy. It is needless to repeat the many arguments for or against complete patellectomy. It is our opinion that each patient should be handled on the basis of his own anatomic disruption, and whenever we can expect a perfectly stable and satisfactory knee joint both as to function and appearance, we are not convinced that the patella should be completely removed.

Each patient must be studied clinically and roentgenologically. The important clinical test is one of estimating the presence or loss of the power of extension; x-ray will reveal the presence or absence of separation or depression of the patellar fragments. In other words, we must remember that we are primarily interested in two things: the damage to the extensor apparatus of the knee, if any, and the relationship of the articular surface of the remaining patella to the femoral condyles. If the quadriceps tendinous expansion is torn with associated loss or impairment of the power of extension, the tear in the tendinous structure must be repaired—this factor should be of primary considera-

FIG. 1. Open repair with wiring; good union but arthritic extensions were evident.

FIG. 2. Simple fracture, immobilization for two weeks.

tion. Patellar fragments which are separated or depressed should be removed. A large proximal fragment, which is so commonly seen, we believe may best be left in place. If the tendinous expansion should be torn and the extension power impaired, roentgen rays will almost always reveal separation of the fragments of 1 or more cm. A patellar fracture that has resulted from indirect violence is practically always associated with wide separation of the fragments. This is, of course, to be expected if one remembers the anatomic relationship of the patella to the quadriceps expansion. Patients not revealing evidence of a tear in the tendinous expansion, either clinically by impaired extension or roentgenologically by separation of fragments but in whom x-ray reveals marked comminution of the patella with depression of the fragments, are best treated by excision of all the depressed fragments, including all of the patella if so involved; one thus avoids development of a derangement of the normally smooth apposition of the patella to the femoral condyles which could logically lead otherwise to arthritic changes or limited flexion of the knee joint. Figure 1 shows the end result of a patella fractured in 1943. Open repair with wiring was done

elsewhere. The patient was seen here fifteen months later complaining of aching discomfort and swelling of his knee. Flexion was limited to less than a right angle. X-ray showed the fracture to be well united but also revealed arthritic extensions from the lateral margin of the patella and its articular surface to be irregular. This could have been avoided by at least partial patellectomy at the time of open repair.

All cases of fracture of the patella do not require an open repair. Direct trauma frequently will produce a transverse or comminuted fracture with no separation or depression of the fragments nor definite impairment of the power of extension. Approximately 60 per cent of our cases of patellar injury were of this nature. They can be easily managed by simple immobilization in extension for two to four weeks. We have observed two cases in which a simple transverse fracture received no external immobilization whatsoever, with perfect healing resulting, the relatively uninjured quadriceps tendon to which the patella is adherent apparently acting in an immobilizing capacity on the patella. We do not believe that immobilization should be intentionally avoided, however, and for all simple fractures not requiring open
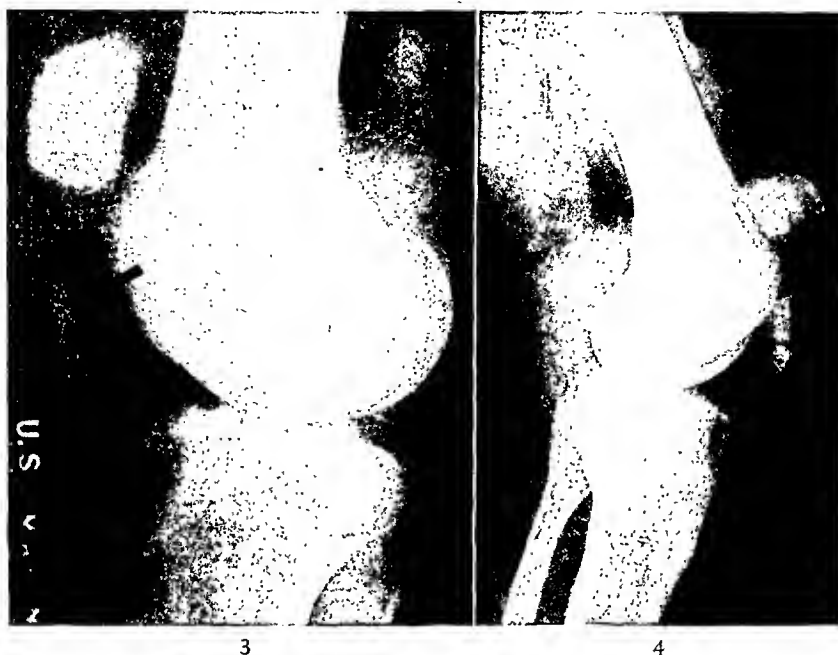
FIG. 3. Direct trauma; avulsed lower fragments with considerable separation; quadriceps expansion torn. This was repaired and the lower fragment removed. Excellent results were accomplished.
FIG. 4. Comminuted fracture with displacement; open repair with removal of displaced fragments and aponeurotic resuturing. Excellent results were attained.

repair we routinely apply a cast maintaining extension of the knee joint for approximately two to four weeks although we allow weight-bearing almost immediately. (Fig. 2.)

TECHNIC OF OPERATION

We do not believe that these patients benefit by any delay and in those patients requiring open reduction we prefer to operate within a day or two after the injury if the patients' condition is satisfactory for surgery. Compound fractures, of course, are treated immediately.

Because of various uncontrollable exigencies, a few of the patients have had operative exposure postponed for several days, and we believed that in these cases re-approximation and closure of the torn aponeurotic expansion was attended with greater difficulty when the period of delay was longer. With prolonged retraction of the quadriceps muscle, there appears to be associated shortening and thickening of the tendinous structures which must be overcome during repair.

The type of skin incision is of little importance, but we generally use the median parapatellar approach with which adequate exposure is obtained. The skin flap is retracted laterally exposing the patella with the overlying quadriceps expansion and patellar ligament. All blood clots are removed and all depressed patellar fragments are carefully freed from their attachment to the overlying tendinous structure which is considerably thinner in its portion immediately over the patella. If a large proximal fragment of the patella is intact, its inferior edge is made smooth and it is left in place. If the patella is completely shattered and fragmented, and especially if the fragments are depressed or their articular surface is rough or uneven, we believe it advisable to remove the entire patella rather than run the risk of later developing a "rough" patellofemoral apposition. The torn lateral tendinous expansions are then carefully approximated and closed with interrupted cotton or chromic catgut sutures including, of course, that portion of the tendinous struc-

ture over the patella itself. (Figs. 3 to 5.)

To obtain firm apposition of the patellar tendon to the tendinous expansion over the remaining patella a pair of holes are sometimes drilled through the inferior margin of the patella in an obliquely distal direction so as not to pass through the under surface of the patella; a No. 1 chromic suture is then passed through one of these holes and the proximal end of the patellar tendon is picked up with the suture which is then passed back through the remaining hole and finally tied on the ventral surface of the patella.

The wound is then closed in the usual fashion and the extremity is supported in extension in a posterior plaster splint which is maintained for ten days. At the end of that time the splint is discarded and the skin sutures removed. Weight-bearing is begun within two weeks and unlimited ambulation is achieved within six weeks.

SUMMARY AND CONCLUSIONS

There is considerable controversy at the present time concerning the proper treatment of patellar fractures. The last few years has seen a trend toward patellectomy as the procedure of choice. In some quarters it is now being recommended for all patellar fractures.

Conservative and proper handling of these fractures as in all others primarily is based on understanding the anatomy involved. The majority of patellar fractures do not need open repair but there are those that can be handled properly in no other way.

Removal of part or all of the patella is often necessary to obtain a stable and well functioning knee joint. It must be emphasized that the patella *per se* is of secondary importance when the lateral tendinous expansions are torn, and a good end result is dependent upon proper suturing of the tendinous structure in-
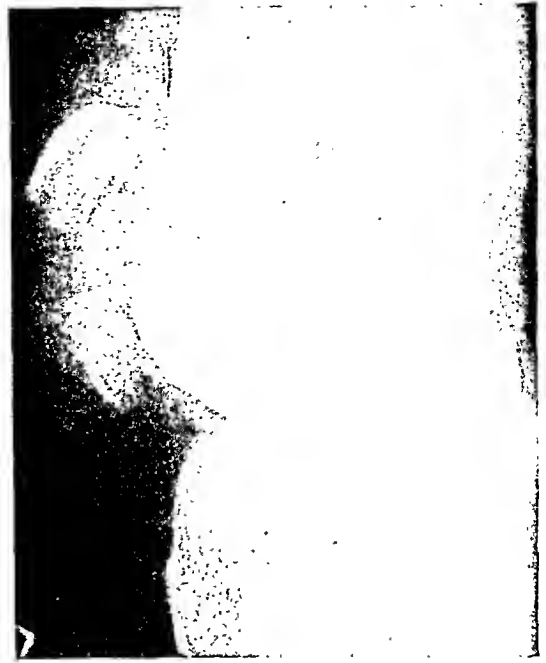
Fig. 5. Comminuted fracture with separation of major fragments and wide tear of quadriceps expansion. Distal fragment was removed and the fascia repaired. There was an excellent result.

volved. A smooth patellofemoral apposition must be obtained to avoid future arthritic manifestations or limitation of knee function.

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RECURRENT DISLOCATION OF THE SHOULDER

MODIFICATION OF BANKHART CAPSULORRHAPHY

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RECONSTRUCTION of the anterior capsule of the shoulder joint has proved to be a most satisfactory method of preventing further dislocations of the shoulder. The technic as described by Bankhart is, however, a difficult procedure and quite traumatic to the shoulder joint in some instances. Many surgeons have given up the anterior capsulorrhaphy due to the technical difficulties involved. These same individuals agree that the operation is most effective in the prevention of further recurrences.

Numerous modifications of the Bankhart procedure have been published in recent years. These modifications advocate either a new instrument to make the necessary holes in the glenoidal rim or various forms of internal fixation of the capsule such as tacks, screws and staples. The author has used tacks as a method of fixation of the capsule of the glenoidal rim in four cases, with satisfactory results. The eventual fate of these tacks is still unknown. Furthermore, an occasional patient may be prone to attribute any residual postoperative distress to these radioopaque objects. For these reasons the technic to be described is now advocated.

Since January, 1945 the "pull-out" wire (as described by Bunnell) has been employed in performing Bankhart capsulorrhaphy. Since that time, fifteen cases have been repaired by this method. No originality is claimed.

TECHNIC

The patient is prepared and draped in order to expose the posterior as well as the anterior part of the shoulder girdle. The skin incision begins at the level of the coracoid process and extends along the

deltopectoral groove about 5 inches. (Fig. 1A.) The deltoid and pectoralis major are separated. The coracoid process is osteotomized and along with the muscles that attach to it reflected inferiorly. The subscapularis is severed near the insertion and retracted medially. Caution must be exercised so that the capsule is not incised when the subscapularis is divided. In the event that the capsule is inadvertently incised repair may be difficult to accomplish. The capsule should be divided near the glenoidal margin with the arm in external rotation. Sufficient capsule must be retained laterally to the glenoid to overlap the glenoidal margin and still preserve external rotation.

The medial portion of the capsule is reflected toward the midline. The anterior portion of the glenoid and neck of the scapula are roughened with a gouge and mallet. Two drill holes large enough to permit the passage of a Kirschner wire are made adjacent to the glenoidal margin. One hole is made near the inferior margin and the other just above the mid-portion of the joint anteriorly. (Fig. 1B.) Two straight needles 5 to 6 inches long made from Kirschner wires are used to place the pullout wires which are usually No. 26 stainless steel. One of these needles is placed at each end of an 18-inch length of the pull-out wire. A second piece of wire with both ends on one needle is then looped over the first wire. The two needles are then threaded through the lateral portion of the capsule and into the holes in the scapula. (Fig. 1C.) The position of the wire in the capsule is important. Excessive capsule will be conducive to recurrences whereas a limited amount of capsule will limit external rotation. The needles
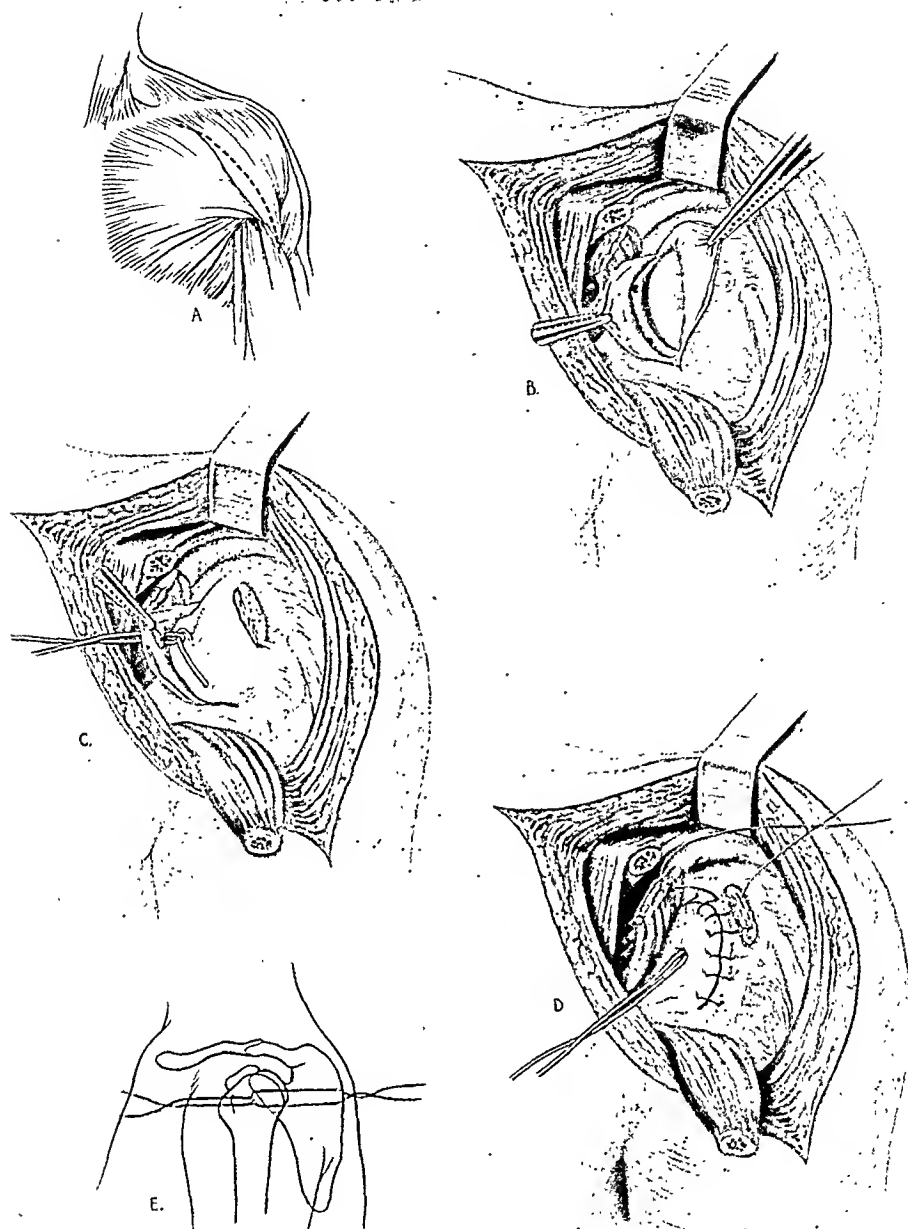
FIG. 1. Bankhart reconstruction for recurrent dislocation of shoulder using pull-out wire technic. A, skin incision; B, position of holds and at rim of glenoid; C, relations of wire to lateral and to medial positions of capsule; D, subscapularis being sutured in position. Wires pulled directly anterior and in some instances may have to pierce the subscapularis; E, sagittal view showing position of the wire.

are then pushed through the scapula and out posteriorly. Before pulling the needles completely out posteriorly it is well to have a flat metal object placed in the path of the needles to prevent piercing the sterile drapes when the needles are pulled through. After the wires are pulled through they are tied over a gauze roll. The pull-out wire with both ends on one needle is now brought through the soft tissue in a path directly anterior to the joint (Fig. 1E). The medial portion of the capsule is plicated over the lateral portion. The subscapularis and coracoid are sutured back into position and the wound closed.

POSTOPERATIVE CARE

A plaster Velpeau dressing is applied. The wire is removed from three to four weeks postoperatively by cutting that portion projecting posteriorly and pulling the remainder out anteriorly by the pull-out loop. All of the author's patients of this type have been young individuals. Most of them have been held in a plaster Velpeau dressing for six weeks. Occasionally Velpeau has been discarded at four weeks. In these cases the patient wears a sling for two additional weeks. Gentle shoulder exercises are then started. Motion has not been forced. From experience it has been found that normal motion is regained in a few months and supervised physiotherapy is not necessary. The patient need only be instructed in the proper exercises.

COMMENT

The author has used the pull-out wire in many operative procedures beside Bankhart capsulorrhaphy and has never seen any infection following its use.

In some early cases smaller caliber wire was used. In the third patient the wire was intact on the tenth day when the sutures were removed. However, at three weeks it was noted that the wire had broken off posteriorly just below the skin. That portion of the wire that held the capsule in contact with the scapula had not moved so the final result was not impaired. Since that time, heavier wire has been used, usually No. 26, or when not available, No. 24.

CONCLUSIONS

A modification of Bankhart capsulorrhaphy for recurrent dislocation of the shoulder is presented. No originality is claimed. Experience with fifteen cases has proven that the pull-out wire greatly simplifies Bankhart capsulorrhaphy. Sufficient time has not elapsed to present a follow-up study on these cases.

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TREATMENT OF ACUTE APPENDICITIS
WITH PERFORATION*

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IN spite of rapid advances in the care of the surgical patient the incidence of operative mortality in acute appendicitis with perforation is still alarmingly and unnecessarily high. This is borne out by the many papers published in recent years in which the mortality rate varies from 10 to 20 per cent. This high mortality rate is due in all probability to many factors, all of which have been amply discussed in other papers. It is our belief that the actual technic of the operative treatment has been neglected and that far too little attention has been directed to this phase of treatment. In this presentation the results obtained in the operative treatment of 219 cases of acute appendicitis with perforation are analyzed. All of these patients were treated in one hospital by several surgeons. Only one technic or method was employed in the surgical handling of these patients.

In order to understand more clearly the problem of acute appendicitis with perforation a short review of the pathologic processes is necessary. The appendix is served by terminal or end arteries arising from the ileocecal artery. Fecoliths or other forms of obstruction tend to occlude the mural vessels and thus the poorly nurtured tissues are more prone to develop gangrene and infection. In the early stages of appendicitis the infectious process is localized to the appendix and the surrounding tissues. The appendix may become gangrenous and covered with fibrin, producing enough reaction so there will be free exudate in the area. The term local peritonitis has been applied to this type of process. There is no perforation and therefore cases in this classification will not be included in this discussion. Because of the

already weakened wall and the abundance of fibrin, the process within the appendix may go on to perforation with discharge of the appendiceal contents into the abdominal cavity. If the process of inflammation has been walled off by the omentum and surrounding structures, perforation will occur into a fairly well sealed off cavity preventing the spread of infection. This results in an abscess which may be located in almost any portion of the abdominal cavity, as was shown by Auchinloss,[1] since it is governed by the position of the appendix. The appendix is usually found within the cavity and may be completely sloughed away. The abscess may vary in size and quantity of pus and the thickness of its wall. The older the abscess, the thicker and more shaggy will be its wall, consequently the less danger there may be to open the abscess cavity without the danger of spreading the contents to the rest of the abdomen. It is apparent that the body has set up its own barriers and all due consideration should be shown to this protective mechanism This will be borne out in the rest to follow

If the omentum does not wall off the infectious process, the products of perforation may be disseminated throughout the entire peritoneal cavity and generalized peritonitis will result. In perforation with abscess usually only the parietal peritoneum is involved, whereas in generalized peritonitis both the parietal and visceral peritoneum are afflicted. At operation the peritoneum will be found to be congested, edematous and friable. The loops of bowel are moderately distended, exudate will be found in all corners which may vary from thin and oderless to thick, creamy, foul-

smelling pus. The appendix may lie in any position and frequently fecoliths may be found lying free in the abdominal cavity. In addition the meso-appendix is friable and the vessels are found to be thrombosed. The cecum may show effects of the infectious process by the presence of varying degrees of typhlitis. Generalized peritonitis is usually a rapidly spreading process, with a characteristic clinical picture in which the patient looks seriously ill, is often toxic, the skin is hot, dry and dehydrated, the face is flushed with a temperature elevation of 101° to 104°F., and there is muscle spasm and marked abdominal tenderness. If the process has been long-standing and overwhelming in its effect, diffuse fibrinopurulent peritonitis is the result. As the abdomen is opened the muscles will be found to be edematous as are the peritoneal tissues. When the peritoneal cavity is entered, many fibrinous areas will be encountered on the injected, distended, inflamed bowel. Pus, flaked with fibrin, will be widely dispersed throughout the peritoneal cavity, the adhesions found are readily broken down and bleed profusely. The consistency and odor of the pus varies from patient to patient. It is in this type of peritonitis that the majority of fatalities are found as shown in Schullinger's[29] paper in which 88 per cent of the patients with this form of peritonitis did not survive. The majority of children with acute appendicitis fall in these latter two groups because of two anatomic factors: In children the appendix contains a great deal of lymphoid tissue, presupposing to severe inflammation and concomitant obstruction and perforation. Second, the omentum is less well developed and thusly its protective action in walling off the inflammatory process is minimized.

It is readily apparent that there are now several factors to be considered in the therapy of a patient with perforation: First, the source of peritoneal contamination, the appendix, which may still be leaking and furthering the cause of infection. This continued leak will depend a great deal on the site of the perforation, but since we are not able to determine the possibility of leakage without direct observation, it must be assumed that further contamination is possible. Second, the collection of purulent material within the peritoneal cavity itself must be considered. This purulent exudate may be localized and pooled in an abscess and it should be treated as any abscess, by evacuation of the pus without further spread into the surrounding tissues. If there is no localization, we may follow the line of thought in any unlocalized infection: removal of the body producing the infection if possible and then allow the process to localize or subside. Mechanical intervention only serves to light up the process and fan its flames. The peritoneum has remarkable recuperative powers and usually will handle all but the overwhelming insults, all other things being equal of course. This presupposes that additional contamination is prevented and that the general forces of resistance are maintained at a high level, implying relief from distention, adequate fluid and chemical balance. The presence of purulent material within the peritoneal cavity has long been a source of controversy as to drainage. Yates[32] in his monumental study proved the fallacy of peritoneal drainage and concluded "Peritoneal drainage must be local and unless there is something to be gained by rendering an area extraperitoneal or by making from such an area a safe path of least resistance leading outside the body, there is aside from hemostasis, no justification for its use." This dictum has yet to be disproved.

Mikulicz long before the work of Yates was convinced that tube drainage was of little use since the tube had to be placed within the peritoneal fluid pool and increased abdominal pressure was necessary to secure an outward flow. It was with this thought that the Mikulicz gauze tampon was developed using capillary flow to promote drainage. Gibson[14] not satisfied with either the tube method of drainage or the Mikulicz tampon developed the

Gibson-Mikulicz pack by the addition of a perforated rubber dam. This pack was composed of a sheet of perforated rubber 20 by 20 inches which was rolled in the form of a cornucopia and was inserted into the wound and then packed with gauze. The amount of gauze was more than enough to fill the cavity since in so doing the appendiceal area was walled off and localization was promoted by the resulting adhesions. The abdominal wall was then left open. In consideration of the use of this pack it has been said that the wound was left open. This is in no way a violation of surgical principles as applied to the perforated appendix. On the contrary, in closing a wound that has been thoroughly bathed in pus a medium of traumatized tissue under conditions of heat, moisture and exclusion of air is evolved which is most conducive to the growth of anaerobic germs. Since with a perforated appendix the effect is not one of a single organism but a symbiotic growth of anaerobic micro-organisms, all factors are present for a necrotized and infected abdominal wall. Aside from hernia many surgeons prefer to leave the wound open to the air.

With the use of this sort of pack in which the wound is to be left open, it is evident for several reasons that the most anatomic incision be used. The McBurney incision satisfies all of these requirements. It is so placed that the route to the appendix is along the lateral iliac fossa wall and the entrance into the peritoneal cavity is made as small as possible. The line of incision is such that the appendix or the iliocecal area lies beneath it. No muscles are cut, they are merely separated in the line of their fibers. In addition, this incision by the Weir extension can be used to enter any portion of the abdominal cavity if so necessary. We believe that the right rectus and the pararectus incision in this type of case should be relegated to the histories of surgery and the more anatomic Mc-Burney or Davis incision used. Abdominal surgery of the type necessary for perforated appendix through these incisions is only

limited by the skill and the adaptability of the operator. All of the patients reported in this presentation were operated upon using a McBurney incision and the Miku-licz-Gibson pack.

The 219 cases selected for this study were taken from the records of this clinic and do not represent the cases of a single individual but rather a group of surgeons for as Guerry[17] pointed out the operative mortality of a single skilled operator will be lower than that of a group. All of these patients were treated in one single operative way whether abscess or general peritonitis was found. The patient was operated upon as soon as possible for it was extremely difficult in the face of the complexity of symptoms to make an accurate diagnosis of perforation in all cases. Delay was the case only if the condition of the patient was such that gastric suction for the relief of distention and restoration of fluid and chemical balance was necessary prior to surgical intervention. As soon as the patient was prepared, using all or any of the methods necessary, he was then operated upon at once. Type of anesthetic varied with the age and condition of the patient. Spinal, inhalation, sodium pentothal and local anesthesia were used. No conclusions can be drawn from this small series as to the benefits of one single anesthetic. A McBurney incision was used in all cases; it was placed laterally as far as possible to the iliac crest so that the entrance into the abdominal cavity would be along the parietal peritoneum without disturbing the coils of intestine or the walls of the abscess as the case may be. Thus, the infectious process was disturbed as little as possible. If an abscess was encountered, the contents were aspirated by suction and a gentle search for the appendix was made. This by no means must be misconstrued as a manual hunt, but the cavity should be investigated by direct vision to find the appendix. If readily found, it was removed; if not, surgical investigation was concluded without breaking down the walls of the abscess.

If no localized abscess was found, but rather a generalized peritoneal contamination, again the search for the appendix was held to a minimum. It is of prime importance that no extensive exploration is done since by so doing, the infective media is only further disseminated and the few protective barriers are broken down.

The appendix usually can be found and removed with a minimum of trauma. The method of handling the stump varies again with the individual case. If the walls of the cecum show little or no evidence of inflammation and induration, the stump should be ligated and inverted. But if the walls will not bear the purse-string suture, the stump is ligated and left lying free. It is believed that elasticity of technic is necessary, depending upon the conditions found at the time of surgery. Since all of our wounds are left open, the secondary danger of leak is minimized in the face of the already contaminated peritoneum. After all of the fluid contained in the abdomen has been aspirated, a sheet of plastic or oiled silk should be inserted into the iliac fossa. This sheet measures about 30 by 30 cm. and has 1 mm. perforations 1 cm. apart throughout its surface. This is placed in such a way that a pouch is made into the cavity. This pouch is then filled with gauze packing anywhere from 1 to 2 yards long which completely fills the cavity extending above the level of the skin. The wound is left open with no sutures at all and a massive fluff dressing loosely placed over it. Prior to introduction of the pack, it may be deemed advisable by the operator to introduce Penrose drains into the cavity. This is accomplished with ease since the position of incision makes it possible for the drains to be introduced to the base of the cecum along the lateral parietal peritoneum without crossing any loops of small bowel and in keeping with our belief that drainage to be of any value at all must be local. This pack is advanced, i. e., partially removed, in forty-eight hours and completely removed in fifty-four to seventy-two hours. Any drainage after

this time is believed to be due to the foreign body in the wound and the purpose of the pack has been served. The length of time that the wound will drain varies a great deal but because of the character of the operative wound the layers fall together

TABLE I

Hours before Surgery	Total Cases	Per cent	Total Deaths	Per cent
0–24	37	17.0	4	26.6
25–48	81	36.4	3	20.0
49–72	52	23.6	5	33.3
73–96	15	6.6	2	13.3
97–	29	13.7	1	6.6
336	4			
888	1	2.3		

naturally and by the time the patient leaves the hospital the drainage has ceased and the wound is granulating in from the bottom. Since the wound is left open, hernias do occur but the incidence is less high than one would be led to expect. In addition, the hernias that do occur are a small price to pay for a life or uncomplicated convalescence.

A total of 219 patients were studied in this series, all of whom were treated with the Mikulicz-Gibson pack. These patients include a large number of persons from rural districts, as one might expect, for it has been pointed out that it is chiefly the rural patient that succumbs to a ruptured appendix.[17] Of the patients in this series 43.3 per cent had taken a laxative and of the cases which terminated in death 66 per cent had had some form of cathartic. In addition, delay has a definite bearing on the over-all mortality because there is a more optimum time to operate than others. (Table 1.)

It follows then that the time in which the majority of deaths fell was in the cases over forty-eight and less than ninety-six hours. Table 1 affords no breakdown as to the over-all mortality statistics in the patients with abscessed or general peritonitis.

The cases included in this report may be broken down into the two groups as shown in Table II.

The low mortality rate incident to the patients with abscess as compared to those with peritonitis is to be expected consider-

TABLE II

Type	No. Cases	Per cent	Deaths	Total Deaths
Perforation with abscess.............	82	37.4	3	3.65
Perforation with peritonitis............	137	63.6	12	8.75
Total cases..........	219	100.0	15	6.84

ing the pathologic process concerned with each type.

The presence of acute appendicitis in the teen-age group is generally accepted to be higher than in any other group. This was borne out in our series in which twenty years was found to be the average age. The cases were grouped by decades as shown in Table III.

TABLE III

Decade	Total Cases	Per cent	Deaths	Per cent Total Deaths
I	60	27.9	3	20.0
2	83	38.8	5	33.3
3	31	13.2	1	6.6
4	9	4.2		
5	16	7.1	1	6.6
6	10	4.7	3	20.0
7	6	2.8	2	13.3
8	2	.9		

It may be seen from this Table III that the patients in the second decade of life failed to survive the effects of perforation as well as other age groups although the first and sixth decade had the next highest rate of fatalities. This and the statistics on duration of disease and use of cathartics conforms closely with other papers in which these factors were more completely discussed.[8,19,27]

The deaths in our series were from a variety of causes as one would suspect. These cases are summarized as follows:

1. No. 9876. A forty-nine year old male was seen and operated upon seventy-two hours after the onset of his illness. Generalized fibrinopurulent peritonitis was found at operation. The patient expired three days later of the effects of peritonitis.

2. No. 10862. A male eleven years of age was seen seventy-two hours after the onset of illness. Generalized peritonitis was found at surgery and he died eight days later of the condition found at operation.

3. No. 15508. A male, forty-seven years old, was seen forty-nine hours after the ingestion of "3 doses of salts." At operation generalized peritonitis was found; the patient died six days later of peritoneal infection.

4. No. 17321. An eight year old male was brought to surgery ninety-six hours after the onset of right lower quadrant pain. The patient died ten days later of acute empyema, acute suppurative peritonitis and pulmonary hypostatic congestion.

5. No. 21940. A sixty-two year old male was seen twenty-four hours after onset of lower abdominal pain. Generalized peritonitis was found at operation. The patient died of the effects of distention and toxemia incident to peritonitis four days later.

6. No. 22539. A twenty-six year old male was seen twenty-four hours after the onset of his illness and twelve hours after he had taken a cathartic. Virulent fibrinopurulent peritonitis was found at surgery and the patient expired on the second postoperative day.

7. No. 22784. A seven year old male who had had a laxative early in his illness was operated upon thirty-six hours after the onset. Generalized peritonitis was found. The patient spiked a fever on the twelfth day and shortly thereafter expired. At autopsy a large pelvic abscess was found which had recently ruptured into the abdominal cavity.

8. No. 27257. A fourteen year old girl was brought in 144 hours after she developed abdominal pain accompanied by nausea and vomiting. She had many and vigorous purges right up to the day of medical consultation. Large quantities of fibrin and pus were found at surgery and the patient died three days later.

9. No. 31731. A woman sixty-five years of age had taken a laxative and was seen fifty-six hours later. This patient had generalized peritonitis at surgery but did well postoperatively until a fecal fistula developed accompanied by obstruction which necessitated bowel resection. One week following the latter operation she expired of generalized fibrinopurulent peritonitis.

10. No. 34594. A twelve year old female was not seen until seventy-two hours after the onset of illness. The patient had taken a laxative twelve hours after she became ill. A large abscess was drained at operation. She died two weeks later of subphrenic and brain abscess.

11. No. 39096. A twenty year old female who was seen fifty hours after the onset of her illness had taken a laxative and was acutely ill when seen. Diffuse fibrinopurulent peritonitis was found at operation and she died five days postoperatively of ileus.

12. No. 45620. A six year old female had had four enemas given her by her mother and was seen forty-eight hours later. Generalized peritonitis was found at surgery. The patient died fifteen days postoperatively of bilateral empyema.

13. No. 45665. A fifteen year old male who had delayed for seventy-two hours before surgery was instituted. A large abscess was found at surgery and it was drained. The patient developed pylephlebitis and multiple liver abscesses which were diagnosed before death by roentgenograms and which were confirmed by autopsy. He died on the 110 postoperative day.

14. No. 48703. A fifty-one year old diabetic female came to surgery fifty-four hours after the onset of right lower quadrant pain. She had three enemas during the course of her illness. At surgery an abscess was found and it was drained. The patient died on the eighteenth day of mitral endocarditis and empyema; the diabetes was out of control.

15. No. 50467. A forty-seven year old female was seen forty-eight hours after the onset of abdominal pain and thirty-six hours after she had taken a generous dose of castor oil. The appendix was not found; the peritoneal cavity was bathed in thin, foul pus. The patient expired nine days later after a very stormy course.

Some consideration of the use of chemotherapy must be made because some of the papers compared in Table v were published before the use of sulfonamides. Since 1940, it has been the practice in handling these cases to introduce into the abdominal cavity crystalline sulfonamides up to 5 Gm. In addition, for the past two years we have also introduced 500,000 units of penicillin in the appendiceal fossa. Since the use of these chemotherapeutic agents, all of these patients operated upon by this method have survived. There have been no deaths in this series in the past six years.

In the discussion of cases of this type the complications that may arise is not of little interest. All of the complications listed in Table IV are taken from the group that survived since the deaths have already been summarized.

TABLE IV

Toxic ileus	1
Wound infection	1
Bronchitis	2
Postoperative hernia	9
Bronchopneumonia	2
Obstruction	2
Secondary abscess	8
Pulmonary embolus	2
Empyema	1
Fecal fistula	3
Psoas abscess	1
Eventration	1

It can be seen from Table IV that far fewer abscesses are found than are shown in previously published papers. Of those with obstructions only one required surgery. Fecal fistulas followed surgery in two instances, one following enterostomy, the other following cecostomy. These methods of decompression are no longer used since we believe that the method of continuous gastric suction provides a far better method of decompression relief from distention and its attendant effects. The number of hernias is small, 4.1 per cent. This is subject to some error for many of the patients have not returned for follow-up studies.

We believe that this method of operation and handling of the peritoneal cavity and wound has proved itself as to the results obtained. This may be shown best by the

comparison of statistics published in other papers on the subject of acute appendicitis with perforation. (Table v.)

TABLE V

Author	No.	Deaths	Mortality (per cent)
Coller and Potter[8]	120	10	8.3
Schullinger[29]	571	60	10.5
Gray and MacKenzie[15]	674	89	20.0
Hawk and Woodhouse[19]	189	18	9.5
Rogers and Faxon[12]	671	87	12.9
Meyer, et al.[24]	211	23	10.9
Tashiro and Zinninger[30]	260	27	10.8
Author's series	219	15	6.84

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TREATMENT OF SEVERE SINGULTUS

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HICCUP is defined as a spasmodic and purposeless contraction of the diaphragm, causing sharp inspiration followed by sudden closure of the glottis, which results from many causes or may occur without known cause. It occurs rarely in epidemic form. It is generally reflex in nature, usually being initiated by some abnormal stimulation of the afferent nerve terminal in the diaphragm. Hiccup may be due to stimulation of the respiratory center itself by some agent in the blood or it may follow efferent nerve irritation as seen in alcoholic intoxication, toxic encephalitis or serum sickness.

Some authors state that the motor impulse in the usual hiccup travels over the phrenic nerve. However, this is not entirely true as hiccup is seen occasionally following bilateral division of the phrenic nerve. Clonic contraction of the accessory muscles of respiration, the intercostal and abdominal, assist in producing hiccup and probably produce the hiccup in those cases following bilateral phrenectomy. This is especially true in cases of central nervous system origin.

Persistent hiccup often threatens life by exhaustion, particularly when it complicates surgery. The great majority of cases occur in men; and while the age incidence varies considerably, the majority of cases are found to be males over fifty years of age, the average age being fifty-four and a half. There seems to be a definite period of the year, in April and September,[1] when this condition is seen most frequently. The onset of the complication varies but it generally occurs between the first to the seventh postoperative days. Most postoperative cases seem to follow operations within the peritoneal cavity. However, hiccup is reported frequently as a complication in such procedures as prostatectomy, catheterization, cystoscopy following prolonged indwelling catheters and a rare case is reported following prostatic massage. The malady does, moreover, complicate any surgical or general medical disease.

The literature on the treatment of hiccup is voluminous and the late Charles W. Mayo stated that no disease has had more forms of treatment and fewer therapeutic results than has persistent hiccup. Dean Lewis states that practically every drug in the Pharmacopoeia has been advocated to combat hiccup.

Innumerable forms of treatment have been suggested by the various authors, the most commonly recommended being sedation by barbituates, inhalation of carbon dioxide 5 to 10 per cent with oxygen, pressure over the vagus nerve, gastric lavage, prolonged traction on the tongue, painting of the nasal pharynx with iodine or other strong irritants, the swallowing of gastric irritants, pressure on the eyeballs, chloroform by mouth, administration of antispasmodics including benzedrine hypodermically, infiltration of the phrenic nerve with novocain and, if these measures fail, phrenectomy. Rosenow[1] reported a spasm-producing type of streptococci obtained from the nasopharynx, from milk supplies and from outdoor air during epidemic prevalence of hiccup. He prepared a serum which may be given with benefit in persistent hiccup, both epidemic and postoperative. His conclusion is that persistent hiccup should be considered as a form of mild myoclonic encephalitis. He obtained a significant reduction in the spasms following intramuscular injection of his especially prepared vaccine.

With the exception of Rosenow's paper, most of the literature comes to the con-

clusion that when the aforementioned measures fail, surgery, usually bilateral phrenectomy, is restorted to. The general statement may be made that in severe, persistent, postoperative hiccup, better termed "malignant hiccup" by Dr. Meredith Campbell,[2] phrenectomy was performed in the majority of cases and this phrenic nerve and contracts the diaphragm. The exact modus operandi by which the hiccup is stopped is not clear but apparently the impulses running to the diaphragm are interrupted and probably the muscle itself is tired as a result of the galvanic stimulation.
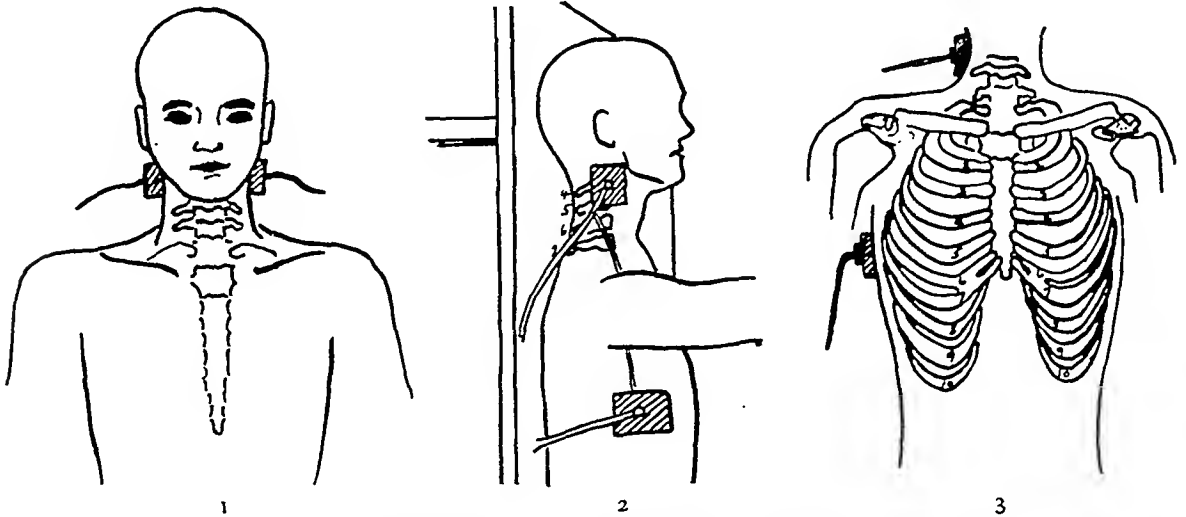
FIG. 1. Two inch square electrodes applied at the level of the fourth cervical for the first stage of treatment.
FIG. 2. Lateral view showing application of electrodes as described in the second stage of treatment. Course of the phrenic nerve is illustrated.
FIG. 3. Anterior posterior view showing pads applied to the right side of the patient as described in the second stage of treatment.

formed in the majority of cases and this procedure is recommended by most authors in cases which are persistent and debilitating.

The spasm of the diaphragm is usually present on both sides but it does occur on one side only and frequently one side seems to be the pacemaker. Most authors report that the left side initiates the spasm. This would indicate that the hiccup is reflex and not due to specific trauma involving the left side of the abdomen.

It is the purpose of this paper to present a very simple form of therapy which has been of extreme value in the treatment of this malady.

Hiccup may be relieved instantly by the application of two small sponge electrodes to the proper sites of the affected patient and the administration of pulsating galvanic sinusoidal current at a comfortable tolerance of 20 to 30 pulsations per minute. This produces stimulation of the

After some experimentation the following procedure was evolved: First, sponge electrodes 2 inches square, previously soaked in saline solution to insure proper contact, are placed on either side of the cervical spine at the level of the fourth cervical vertebra (Fig. 1) and pulsating galvanic sinusoidal current is introduced at a moderate strength, the intensity of current being based on the patient's degree of comfort. In moribund or unconscious patients the intensity of current can be judged by the presence or absence of associated muscular twitching and contractions of the shoulder girdle and neck muscles and the current may be regulated accordingly. The current is administered for twenty minutes.

Following the first step, if it is certain that the left side is the pacemaker, one 2 inch pad is then applied to the fourth cervical region on the left side and a larger pad 4 by 6 inches is applied over the

diaphragm at the anterior axillary line and the eighth rib. (Fig. 2.) The current is administered again for twenty minutes.

If there is any doubt as to which side of the diaphragm is the pacemaker, it can be determined by observation of the diaphragm or by placing the patient under a fluoroscope to see which side initiates the contraction. The pads are then applied to that side which seems to initiate the reflex and treatment is given for twenty minutes. (Fig. 3.)

A third treatment reversing the application of the electrodes to the opposite side of neck and chest is then administered for twenty minutes.

The reason for the sequence of procedure is that following stage one of treatment the hiccup is so slowed down that the pacemaker side can be identified more positively. The pacemaker side should be determined as it is important to give more intensive treatment to that side in some cases.

It has been found that the twenty-minute treatment to each of the three areas gives the most satisfactory results and does not tire the patient unnecessarily, particularly when treatment is administered as often as every three or four hours.

The reason for treating the opposite side after the pacemaker has been determined is that following phrenectomy on the pacemaker side, hiccup persists in some cases and requires a phrenectomy on the opposite side. Because the treatment is so simple, it seems logical to follow the treatment to the pacemaker side with one to the opposite side in order to preclude any possibility of further recurrence of the hiccup.

Five cases are presented to illustrate briefly but specifically the simplicity of technic and its potentialities. The patients were all treated by the method described with slight modifications as experience was gained.

CASE REPORTS

CASE I. C. B., aged fifty-seven was admitted to the hospital on May 3rd and was operated upon on May 11th for acute cholecystitis with cholelithiasis. Hiccup began on May 11th at 12:30 P.M., approximately three hours postoperatively. Hiccups were occasional at first, later were spasmodic and by 7 P.M. they were constant; CO_2 plus O_2 (5 and 95 per cent) were given. The spasms were less violent but they persisted; CO_2 and O_2 were given on the 12th and 13th and, in addition, the patient received $\frac{1}{4}$ gr. morphine, every four hours. There was no relief and hiccups persisted. By this time the patient was in very poor general condition and had had very little sleep. His brief periods of sleep were constantly interrupted by hiccups. At 11 A.M. on May 13th the patient received his first galvanic treatment following the method described above. A second treatment was given at 2 P.M. At 4 P.M. the hiccup was less frequent and at 5 P.M. it was very much less frequent. By the following day the patient's hiccup was entirely cured and he was discharged from the hospital on June 1st.

CASE II. P. K., about sixty years of age, was admitted to the hospital on May 2nd with a diagnosis of subacute bacterial endocarditis. The patient received numerous blood transfusions for a suspected endocarditis and was treated energetically with heperin and sulfa drugs. He first began to hiccup fifteen days after his admission. Hiccup was not regarded seriously until five days later when it was noted in the hospital records as a "continuous hiccup." On this day CO_2 plus O_2 (5 and 95 per cent) were administered and after three days with no relief, the mixture was changed to 10 per cent CO_2. Following this change, the patient was able to sleep at intervals but his sleep was constantly interrupted by hiccups. Sodium amitol was then administered and although this drug induced sleep, the patient hiccuped constantly during sleep. The first galvanic treatment was given at 9 P.M. on May 25th. At 2 A.M. the following day the patient's hiccup was still very pronounced and at 8 A.M. the patient was still hiccuping. The second galvanic treatment was given at 11 A.M. on May 26th, fourteen hours after the first treatment, with marked relief of the hiccup. Twenty-four hours later a third galvanic treatment was given, following which the patient had no further symptoms.

CASE III. Mr. H., about seventy years of age, was admitted to the hospital on May 4th

for observation for possible gastric carcinoma. Hiccup was first noted on July 10th and described as persistent and constant. The following day 5 mg. of benzedrine was given with slight relief. This was repeated every four hours but was replaced on the 12th by oil of cajeput, two drops on sugar every four hours. The benzedrine obviously did not help the patient and the oil of cajeput failed also. The patient was given 1½ gr. of luminol every four hours, following which the hiccups stopped temporarily. On July 13th the notes stated, "Patient is hiccuping continuously and patient states hiccup is driving him crazy." The patient was extremely weak and was having involuntary micturition and was in a pronounced state of exhaustion. Galvanic therapy was first administered on the 14th, four days after the beginning of the persistent hiccup. The nurse's notes stated that at 11 A.M. the patient was hiccuping at short intervals that night but sleeping for long periods. On July 15th hiccups recurred but the patient was well enough to be sent down to Physiotherapy for his second galvanic treatment. Following this therapy the patient slept very soundly that night with no hiccuping. On July 17th a third treatment was given. The patient was discharged from the hospital five days later. No hiccups were mentioned in the clinical record after July 15th. The third treatment was given as a prophylactic measure.

Case IV. A young man approximately twenty-one years of age, was admitted to the Naval Hospital, New Orleans. No detailed records are available on this case. The patient had had a varicocele operation performed in late July or early August. He developed hiccup postoperatively. The hiccup became so severe that the patient lost considerable weight and was unable to sleep. Finally he became extremely exhausted and was unable to eat or drink and was being prepared for a bilateral phrenectomy after weeks of so-called simple measures, including sedation, carbon dioxide, gastric lavage, tongue pulling and general anesthesia. Galvanic therapy was suggested and the operation was postponed. As the galvanic stimulation was given, the response was immediate. The obviously spastic contraction of the diaphragm was diminished after several galvanic impulses were administered and after twenty minutes of treatment

the patient's hiccups stopped for a period of approximately a half hour. The galvanic current was then applied to the other areas and the patient had relief of the hiccup which had persisted for weeks for about two hours; a sufficient length of time for the urologist to cancel plans for surgery and to wonder at the change in the patient. About three hours after treatment the patient began to hiccup again. Consequently, the galvanic therapy was given every four hours for several days until no further spasms were present. About four days later the boy was being wheeled about the Naval Hospital and he was discharged shortly thereafter with no further return of the hiccup.

Case V. Mr. W., aged sixty-seven, was admitted to the hospital on November 5th. The diagnosis was acute cholecystitis with cholelithiasis complicated by hyperthyroidism. After extensive preoperative preparation, an uncomplicated cholecystectomy was performed on November 11th. The patient's postoperative condition was definitely stormy due to his emotional instability. On November 14th late at night the patient's general condition was very poor with auricular fibrillation and extreme restlessness. The patient was given Lugol's solution plus digitalis for his cardiovascular and thyroid symptoms. Late that afternoon, November 15th, extremely marked nausea ensued followed by vomiting with disruption of the abdominal wound. Resuture of the abdominal wound was performed that night and the patient's condition the following forty-eight hours could best be described as critical. On the night of November 18th hiccups were noted but were not persistent or severe. By November 19th the hiccups had become much more frequent and exceedingly aggravating. Galvanic therapy was given at 10 P.M. with marked relief. On the next morning the hiccups were completely absent. However, during the next two days the hiccups recurred for gradually increasing periods and a second galvanic treatment was given on November 23rd. This treatment again stopped the hiccups but twenty-four hours later they were again present and then galvanic therapy was given every four hours for two days with permanent relief.

The patient in Case 1 was first treated forty-eight hours postoperatively and gal-

vanic therapy was repeated in three hours with *complete relief*. P. K. (Case II) did not receive galvanic therapy until seven days after the development of the hiccup. There was relief but some hiccup was still present and fourteen hours later the second treatment was given. Twenty-four hours later a third treatment was given after which no further hiccuping was noted. Mr. H. (Case III) had hiccup for four days' minimum before galvanic therapy was instituted. The first treatment produced excellent results and it is questionable whether the treatments given twenty-four, forty-eight and seventy-two hours later were actually needed. The patient in Case IV was given the first galvanic treatment twelve to fourteen days following the initial hiccup. Each treatment produced relief for a period of approximately three hours but it was necessary to treat this man for two days before the spasms were completely arrested. Mr. W. (Case V) received the first galvanic therapy twenty-four hours after the initial hiccup. The second galvanic treatment was given days after the first treatment. Both treatments produced immediate relief but the hiccup returned later and it was necessary to give consecutive treatments every four hours to obtain permanent relief.

It seems clear that galvanic therapy should be given as outlined every four hours until the spasms have been controlled. A minimum of three consecutive treatments is recommended even though one treatment sometimes dramatically cures the hiccup. In severe, protracted, malignant cases galvanism every four hours for two to three days may be required for permanent relief.

CONCLUSION

Following a review of the literature and a discussion of this procedure with various doctors, the conclusion is drawn that the treatment of hiccup resolves itself down to giving any one of the 200 odd simple-to-complicated remedies previously mentioned; and if these fail, Rosenow's serum or surgery is required. However, surgery involving the crushing or resection of the phrenic nerve is a serious procedure and in the aged and debilitated, in whom this malady is so frequently met, this procedure is rather formidable. It requires an experienced chest surgeon and still leaves the elderly patient in a handicapped state. Unilateral paralysis of the diaphragm usually produces no symptoms but bilateral paralysis results in dyspnea. In addition, coughing is most unsatisfactory and defecation is definitely impaired. Certainly any procedure which will obviate further trauma to an already weakened patient is medical news. A treatment which is as simple as galvanic stimulation need not be delayed until days or a week have gone by to stop the paroxysm. I can think of no known contraindication to the administration of galvanic current for this malady. While some patients may not respond to this utterly simple, inexpensive, non-toxic therapeutic aid, the results obtained from this method have been uniformly excellent and merit further investigation.

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REDUCTION OF MORTALITY IN INTESTINAL OBSTRUCTION*

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A CRITICAL analysis of the factors in mortality is indispensible to the reduction of such mortality. The need for this analysis in relation to intestinal obstruction must be apparent in view of the egregious results obtained in the treatment of this condition over the country as a whole. In a recent presentation[1] a review of the results of leading clinics showed that only a handful of surgeons have succeeded in lowering their mortality rates below 20 per cent and the general average is considerably higher. Since intestinal obstruction is the most common condition for which the surgeon approaches the small bowel and since operations for the relief of such obstructions are among the most common performed by the abdominal surgeon, the problem should be one of general interest and concern. The importance of the lesion may be further emphasized by realization that small intestinal obstruction is the most frequent cause of eventual death in the two most common conditions requiring abdominal surgery, these being hernia (from strangulation) and diseases of the appendix (from inflammatory and post-operative adhesions). It is also significant that the general medical population has witnessed no appreciable decline in mortality from the lesion since shortly after the introduction of Wangensteen suction measures, despite the subsequent advent of Miller-Abbott intubation, Fine's nasal oxygen decompression and more extensive use of electrolytes, blood and plasma.

A review of our own cases may serve to illustrate the pertinent factors in reduction of mortality in this problem. In Table 1 there is a synopsis of 223 consecutive patients with small intestinal obstruction, of whom 170 were subjected to operation. In this series there has been a 6.3 per cent hospital mortality and a 6.5 per cent operative mortality. It will be noted that thirty-six patients had lesions of the bowel requiring resections; this group actually included forty resections, in that two patients had two resections at separate operations and two patients had two loops resected at one operation. Eleven patients requiring intestinal resections had specific lesions of the bowel without strangulation, these lesions being regional ileitis, six cases, primary malignancy (leiomyosarcoma, lymphosarcoma), two cases and metastatic malignancy, Meckel's diverticulum and tuberculosis of the ileum, one case each. One other patient with metastatic carcinoma to the ileum is not listed in this group because the metastatic nodule formed the head of an intussusceptum but is listed under the examples of intussusception. Twenty-five patients subjected to bowel resections had a gangrenous intestine resulting from strangulating lesions, eleven of which were due to hernias, seven due to volvulus, six due to postoperative adhesions and one due to intussusception.

A review of the literature reveals that our hospital and operative mortality represents an appreciable decrease compared with those previously reported in any sizable series. The following factors are those which may be considered to be of greatest significance in this improvement: (1) Use of blood and plasma in large quantities; (2) careful timing of the operative procedure; (3) avoidance of the Miller-Abbott tube with its attendant false sense of security; (4) use of spinal anes-

thesia; (5) abandonment of exteriorization measures; (6) decisive and rapid operative repairs with the least possible trauma; (7) use of "physiologic" incisions which minimize postoperative adhesions, eviscerations and wound infections.

these theories having been proposed more on clinical grounds than on controlled experimental evidence. In this series only two patients failed to revert from the shock picture before operation, one of whom received only small quantities of plasma

TABLE I

Type	Total	Operation	Strangulation	Resected	Operative Deaths	Total Deaths
Hernia						
umbilical..........................	10	10	7	3	1	1
inguinal...........................	52	51	33	4	2	3
femoral...........................	5	5	5	1	1	1
postoperative ventral...............	9	9	7	2	1	1
internal..........................	5	5	5	1	0	0
Inflammatory adhesions...............	14	6	1	1	1	1
Postoperative adhesions...............	89	47	12	5	1	1
Intussusception.......................	9	9	9	1	1	1
Volvulus............................	15	15	15	7	0	0
Mesenteric vascular occlusion..........	3	2	3	0	2	3
Malignancy						
metastatic..........................	2	1	0	1	0	1
primary...........................	2	2	0	2	0	0
Meckel's diverticulum.................	1	1	0	1	0	0
Regional ileitis.......................	6	6	0	6	1	1
Tuberculosis of ileum.................	1	1	0	1	0	0
Total..........................	223	170	97	36	11	14

Hospital mortality 6.3 per cent.
Operative mortality 6.5 per cent.

FACTORS IN MORTALITY REDUCTION

Use of Blood and Plasma in Large Quantities. This is essential to many cases of intestinal obstruction because of the tremendous loss of these elements in the presence of strangulation. As a result of venous obstruction which always precedes arterial occlusion there is marked and rapid increase of intracapillary pressure sufficient to allow massive transudation through the capillary wall, first of plasma and later, when venous obstruction is more complete, of increasing numbers of red blood cells. This loss may occur into the bowel wall, into the bowel lumen and into the peritoneal cavity, and it often measures from 1 to 2 L., an amount which readily explains the frequent shock and preshock state of the patients. In this shock syndrome various "toxins" have been incriminated,

because of limited supply and the other having gangrene of the entire small bowel and nearly one-half of the colon as a result of superior mesenteric arterial thrombosis, showing a massive hemoperitoneum at autopsy. This consistent response to anti-shock therapy is incompatible with the beliefs of the advocates of the toxin theories. However, to reiterate, the amounts of plasma required are not to be measured in cc. but often rather in L. In general, the literature reveals lower mortality rates in strangulated hernias than from other strangulations. This may be explained by the limiting envelope of the hernial sac which will restrict the amount of exudate lost by capillary seepage. It is worthy of comment that one should not allow assurance that bowel is viable to interrupt restorative measures. The capillary bed which has been injured by both direct

trauma and anoxia will be subjected to another sudden increase of intraluminal pressure when the arterial occlusion is relieved by correction of the strangulation, and the seepage of blood and plasma through the permeable vascular walls will continue after the operation is concluded. Therefore, upon occasions a patient operated upon for strangulated hernia may be seen to go into shock for the first time a few hours after operation. This relapse should be anticipated and prevented by prophylactic blood or blood substitutes.

Timing of the Operative Procedure. This is probably the factor with which we are most at variance with many other writers on this subject[3-9] who generally favor routine early or immediate exploration. The urgency characterizing their attitude toward therapy is based on fear of transition from strangulation to gangrene, a fear which is well founded but one which we believe has been responsible for operative intervention in many cases before certain minimal phases of preoperative care have been completed. No other condition encountered by the clinician or surgeon causes such rapid and drastic changes in body physiology. Dehydration, loss of blood protein and blood cells and depletion of sodium and chloride ions are all salient features of acute obstruction. These blood changes can be partially corrected fairly adequately and rapidly, but the alterations in tissue physiology require a much longer time to correct. These factors make the patient with obstruction a poor risk. Also distention of itself increases operative risk by several mechanisms, among which are elevation of the diaphragm with decrease in vital capacity, alterations of mediastinal pressure relationships and position interfering with cardiac function and venous return causing pooling in the visceral vascular bed. Distention also interferes, often to a dangerous degree, with the surgeon at the time of operation. These factors add to the mortality risk. The relief of distention and the correction of physiologic alterations render the pa-

tient a better risk, whereas the loss of time required to accomplish these benefits may allow the onset of gangrene. Obviously, the attempts at observance of these mutually exclusive dicta leave the surgeon in a quandary from which individual judg-

TABLE II

MORTALITY RATES IN REPORTED CASES OF ACUTE OBSTRUCTION OF THE SMALL INTESTINE

Year	Author	No. Cases	Mortality (Per Cent)
1930	Holden[10]	....	19.0
1938	Scudder, Xwemer and Whipple[11]	2150	24.0*
1938	Wangensteen[12]	157	17.9
1940	Schlieke, Bargen and Dixon[13]	133	21.8
1940	McKittrick and Sarris[4]	136	20.0†
1942	Dennis and Brown[2]	48	13.3
1943	Dennis and Brown[14]	110	15.5
1944	Dennis[15]	53	15.1
1945	Moses[1]	118	8.5‡
1946	Hunt[16]	41	7.3
1946	Moses	223	6.4§

* Viable bowel only.

† Hospital mortality; operative mortality 18 per cent.

‡ Hospital mortality; operative mortality 7.8 per cent.

§ Hospital mortality; operative mortality 6.5 per cent.

ment is his only deliverer. We have based our plan of therapy upon the premise that it is safer to insist upon a reasonable general condition of the patient before operation is contemplated and consider that fear of gangrene is of secondary importance. The execution of this policy sometimes results in the delay of surgery for several hours, and it is possible that a resection or two may have been required as a result. Trite as it may appear, however, it is preferable that a patient survive a resection than die from a simpler operation. A previous article has outlined the general criteria by which we judge the proper timing of operative intervention.[1]

The Miller-Abbott Tube. The Miller-Abbott tube has had no place in the management of mechanical obstruction in this

series. The flocculent, mossy secretions aspirated from the stomach and small intestine in intestinal obstructions easily plug an ordinary Levine tube and produce this effect even more readily in the Miller-Abbott tube with its much smaller lumen. Furthermore, the only type of obstruction which may be relieved by suction measures is that due to adhesions in which, in our experience, the simpler nasal Levine tube suction has been adequate. In this series there have been 103 cases of obstruction due to adhesions, of which fifty-three (51.4 per cent) required operative intervention. In these fifty-three cases operative findings were such that there seems little reason to believe that Miller-Abbott intubation would have been of any avail in preventing operation. These findings were distributed between volvulus, internal herniation and marked kinking of narrowing of the lumen. It must be borne in mind also that the symptoms of obstruction even in the presence of strangulation are mainly due to distention of the proximal bowel. Since a completely successful Miller-Abbott intubation may entirely empty this proximal intestine, one may be deprived thereby of the more valuable symptoms and signs contributing to judgment. Many surgeons have been lulled into a state of false security for a time by the use of this gadget, later to realize after loss of invaluable hours or days that the local disorder had advanced to a grave degree. In other types of obstruction than that due to adhesions use of this tube is too time-consuming to allow its use.

Use of Spinal Anesthesia. Spinal anesthesia was forced upon us by the dire man-power shortages during the war, and our earlier efforts were attended with considerable misgivings. Fortunately, however, probably due to the policy of more meticulous preoperative care, we failed to witness the severe shock which we had expected, we found that the dangers of aspiration of vomitus were minimized and we noted that we were completing the operative maneuvers more easily and safely

and especially avoiding the dangerous battle against spewing intestine during the definitive surgery and during wound closure. We now favor spinal anesthetics almost routinely and rarely exceed a dosage of 75 to 100 mg. of procaine intrathecally.

Exteriorization Measures. In the management of gangrenous bowel exteriorization measures have been used only twice in this series, in one patient with 11 feet of a gangrenous ileum and jejunum and in the other with two gangrenous loops which had perforated within an umbilical hernial sac. The former patient required three subsequent operative repairs of the resultant fistula before repair was effected, with a consistent and progressive period of emaciation during the intervening weeks although recovery finally ensued. The second patient experienced a similar course and eventually died as a consequence. We have found ileostomies so debilitating and depleting of general and protein reserves with serious excoriation of the abdominal wall that we have since completely abandoned the procedure. It is true that the disparity between bowel lumina, the vascular engorgement and friability of the intestine being sutured and the high bacterial count within the proximal loop combine to make anastomoses under obstruction conditions more dangerous than under elective conditions, but experience indicates that closed "aseptic" anastomoses, turning in a narrow cuff of bowel and using interrupted non-absorbable suture layers, is justifiably safe. Among thirty-six patients in whom forty resections were performed only one suture line leaked, with a resultant fistula which was later successfully closed. This patient had been operated upon on four previous occasions, twice for tuberculosis of the urinary bladder and twice for the relief of obstruction due to operative and inflammatory adhesions. It is believed that a partial obstruction below the anastomosis line was primarily responsible for the secondary fistula. Of the thirty-six patients who had resections three died (8.3 per cent). One

patient, who had an ileocolic intussusception resulting from metastasis to the ileum following a previous nephrectomy for carcinoma of the kidney, suffered a fatal blood transfusion reaction eleven days postoperatively. The second patient whose umbilical hernial sac contained two perforated gangrenous loops has just been described. The third patient died of generalized peritonitis following spillage of the intestinal contents during the lysis of inflammatory adhesions secondary to repeated bouts of salpingitis.

Use of spinal anesthesia in the relatively small doses employed has necessitated *decisive and rapid operative maneuvers.* Longer procedures may be afforded by larger doses but with increased risk of serious toxic reactions. We place considerable emphasis upon tracing of the bowel from the ileocecal valve proximally, avoiding the handling of distended intestine and especially avoiding deliverance of the enlarged loops through the incisions. The use of gauze, either wet or dry, or abdominal packs is avoided because the abraiding effects of these agents on the serosa of the viscera are potential sources of later adhesions. All unnecessary maneuvers are avoided, such as the lysis of adhesions which are not obstructing, coincident appendectomy and the like. On occasions in the critically ill the procedures have been limited to simple incision of a hernial sac under local anesthesia, a more propitious moment being awaited for actual herniorrhaphy.

Use of Physiologic Incisions. Physiologic incisions, such as the McBurney and Pfannenstiel, have probably played a minor rôle in mortality reduction but have minimized concern about evisceration, wound infection, hernia and parting of peritoneal sutures which leave a bare area exposed to the intestinal serosa.

SUMMARY

A series of 223 cases of small bowel obstruction is reported in which 170 patients were operated upon, with an operative mortality of 6.5 per cent. The hospital mortality for the entire series was 6.3 per cent. If the three cases of complete superior mesenteric artery occlusion are excluded, the operative and hospital mortality rates are 5.4 per cent and 4.9 per cent, respectively.

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Case Reports

VOLVULUS OF THE SIGMOID*

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VOLVULUS of the sigmoid colon has been considered a rather uncommon cause of acute intestinal obstruction. Most surgical textbooks and treatises on this subject either mention it casually or neglect it entirely. Ligat and Overend[12] correctly state: "In our experience recurrent sigmoid volvulus is not an extraordinary rarity and it is our belief that, apart from the danger of fatal strangulation, it is responsible for a considerable amount of disability. The diagnosis can be of great difficulty . . . ." Volvulus of the sigmoid is stated by Mummery[14] to form 4 per cent of all cases of intestinal obstruction. Hinton and Steiner[6] estimate that it accounts for less than 1 per cent of acute intestinal obstruction.

We are reporting eight cases of proven volvulus of the sigmoid colon from a large general hospital from 1935 to 1943. It is our opinion that volvulus of the sigmoid is certainly not rare and is an etiologic condition to be considered in every case of acute intestinal obstruction. The mortality in volvulus of the sigmoid has been stated to be between 30 and 45 per cent.[6] The high mortality is undoubtedly due to the lack of recognition of the cardinal features of the disease and the difficulty in diagnosis; certainly once the diagnosis has been established early in the course of an acute attack of volvulus, surgical therapy is simple and effective. In only one of the eight cases in this series were the routine film studies of the abdomen taken on admission incorrectly interpreted. These same x-ray films were seen on the following day by Dr. William Snow, roentgenologist to the hospital, who made a diagnosis of volvulus of the sigmoid without knowledge of the operative findings. In the remaining seven cases the diagnosis was made preoperatively by staff surgeons through a correlation of the history, physical signs and roentgenograms.

We are convinced that an accurate diagnosis of sigmoid volvulus can be made in the majority of cases of volvulus of the sigmoid colon by examination of films of the abdomen in conjunction with the history and direct examination of the patient, without the use of roentgen contrast media.

ANATOMY AND PATHOLOGY

Volvulus of the sigmoid is defined as a condition in which the pelvic colon or a portion of the pelvic colon has twisted upon itself or around its mesentery. This portion of the colon normally has a long mesentery, but abnormally other portions may also have elongated mesenteries and be subject to torsion. Ligat and Overend[12] state that the gut may twist on its mesenteric axis or on its own long axis and the two forms may co-exist. The mesentery of the pelvic colon is a fan-shaped fold attached to the posterior abdominal wall. Its arrangement gives the pelvic colon a narrow pedicle which can be further narrowed by a variety of pathologic processes. On opening the abdomen in a case of acute sigmoid volvulus, two huge

loops of gut present themselves and appear to occupy the entire peritoneal cavity often extending to the liver or to the left diaphragm. The picture is perhaps best described as resembling an inflated automobile inner tube doubled on itself. If the bowel has not become gangrenous, only a small amount of serosanguineous fluid may be present in the peritoneal cavity. The twist usually occurs at the rectosigmoid junction above the peritoneal reflection. After deflation by gentle untwisting and passing a rectal tube beyond the twist, the tremendously redundant sigmoid and elongated mesosigmoid can be made out. In our series, with exception of the elongated mesosigmoid and redundant sigmoid, we have not been able to substantiate the presence of adhesions, chronic inflammatory processes or new growths of the mesenteries which have been reported in the literature as causing sigmoid volvulus. The pathologic picture does not differ from bowel strangulation as seen in strangulated hernia. Mummery[14] states that the distention is more marked in volvulus because fermentation occurs more readily in the colon and the gas accumulates to a still greater extent because of lack of absorption from an insufficient blood supply. Characteristically, as in any bowel strangulation in which the circulation is interfered with, the affected loop becomes dark in color, the walls become edematous and bloody serum exudes into the lumen of the bowel. In one case reported here actual gangrene had occurred and a foul-smelling exudate was present in the peritoneal cavity. It is to be remembered that volvulus of the sigmoid is a closed loop obstruction; and if the twist is complete, the circulation is quickly shut off and gangrene may rapidly set in.

ETIOLOGY

The actual etiology of this condition has not been definitely established. In our cases we have not noted the presence of factors referred to above, which have been described as predisposing to volvulus.

The outstanding elements present were the greatly elongated mesosigmoid and the tremendously redundant pelvic colon. Ligat and Overend[12] divide the causative factors into two groups, primary and secondary. The primary factor is stated to be the abnormal length of the pelvic colon. The secondary factors are considered to be the elongation of the pelvic mesocolon, the narrowing of the base of attachment of the pelvic mesocolon to the sacrum and, finally, the formation of an axis of rotation by adhesions or by the close approximation of a loop of bowel. These authors believe that the actual crisis may be precipitated by physical effort or violent purgation. They speak of a major type of crisis in which the degree and duration of torsion are sufficient to interfere with the function and circulation of the bowel. The minor crises in which the torsion is incomplete may be frequent and difficult to diagnose.

The excessive length of the pelvic colon is believed to be of three types: (1) the persistence of a fetal type; (2) gross dilatation of the colon as seen in the general colonic changes of Hirschsprung's disease. It is generally agreed that the latter condition in itself is not a common factor in sigmoid volvulus. In none of the cases reported herein did the condition occur in childhood and we did not note the presence of other colonic changes as described by Hirschsprung.[7] (3) The acquired type in which the elongation of the pelvic colon is due to adaptation to dietary habits. The condition is stated to be common in Russia and the Baltic States where about 30 per cent of all cases of acute intestinal obstruction is due to volvulus of the sigmoid. This has been attributed to the coarse vegetable diet which permits fecal material to be stored in the pelvic colon. In this connection it is interesting to note in this series the comparative frequency of this condition in the colored population although no distinctive or unusual dietary habits have been observed in this group. Bloodgood[2] in 1909 reported two cases of volvulus of the

sigmoid, calling attention to the presence of adhesive bands in the left abdomen which might lead to acute volvulus or to partial obstruction. One case reported by this author is remarkable in that in a period of sixteen years thirty-two attacks of acute volvulus occurred. After the last attack a giant sigmoid colon was resected.

DIAGNOSIS

In the series reported in this paper the preoperative diagnosis of a sigmoid volvulus was made in all cases by examination of plain roentgenograms of the abdomen in conjunction with direct examination of the patient. It has been stated repeatedly in the literature that the preoperative diagnosis of volvulus of the sigmoid is difficult clinically and that without the use of the x-ray it is often impossible to differentiate from any other acute obstruction. Carnes Weeks[17] reviewed sixty-three cases of this condition from the literature and reported one of his own. He mentions the incidence as twice as common in the male and occurring more frequently in persons in middle life. Constipation was present in 65 per cent of the cases reviewed by him. Periods of obstipation averaging four and one-half days were associated with the acute attack. Abdominal pain was present in all cases but was not in any way characteristic. Vomiting was present in only twenty of the cases and thirty-one patients gave a history of previous similar attacks. In only three cases was the diagnosis made by x-ray with the use of contrast media. Mummery[14] states that volvulus of the sigmoid should be suspected in the presence of acute intestinal obstruction in which marked distention is present but no vomiting. Power[15] mentions localized abdominal distention as being of value in the diagnosis (v. Wahl's sign). Ligat and Overend[12] emphasize the occurrence of watery and blood-stained diarrhea after rather than during an attack.

In our own series there have been no clinical features which would serve to distinguish this condition from any other

acute obstruction of the large bowel. The bowel distention has been great in all cases and the outline of loops of dilated gut could be made out on the abdominal wall. In two cases there were previous admissions for similar acute episodes. The youngest patients were twenty-two and thirty years of age while the remainder were between thirty and sixty years. Abdominal pain was present in all cases but was not different from that associated with other causes of bowel obstruction. At times, however, the pain was so intense as to make one consider differentially the presence of an acute perforation of a hollow viscus, renal colic, acute pancreatitis or thrombosis of mesenteric vessels.

Roentgenologic Diagnosis. The use of contrast media in the roentgenologic diagnosis of volvulus of the sigmoid has been described. Ligat and Overend[12] make use of an air and barium filling of the colon and emphasize the screw-like torsion of the mucous folds of the colonic relief. Weeks[17] in his analysis of sixty-three cases of volvulus collected from the literature mentions that in only three cases was the diagnosis made by x-ray study. Hall[5] outlined the volvulus by barium enema in two cases. The barium passed the obstruction and could be partially evacuated. Baccaglini[1] mentions a case of acute sigmoid volvulus in which the preoperative diagnosis was made by "characteristic" plain films followed by barium enema but he did not describe the roentgenologic features. Laurell[11] in an exhaustive study of volvulus of the sigmoid reproduces numerous film studies with opaque contrast media but there is no mention or reproduction of preoperative plain films. Riglar[16] described six cases of volvulus of the sigmoid with the following pertinent roentgenologic features: (1) Tremendous distention of the sigmoid flexure which pushes upward from the bony pelvis, almost always to the right, and reaches to the edge of the liver or the diaphragm. (2) The presence of a double point of obstruction as demonstrated by the barium enema.

(3) The enormous accumulation of fluid and gas in the closed loop and the relatively only moderate distention of the remainder of the colon.

For many years at Harlem Hospital it has been the routine, instituted by the senior author, to make plain film studies of the abdomen in all cases of suspected acute intestinal obstruction. It is gratifying to note that survey films of the abdomen are being studied by other surgeons throughout the country. We believe that the method of taking the films is of sufficient importance to warrant quotation from the paper by the senior author:[4]

"The most complete and accurate data for roentgenological study will be obtained if plates are taken in the following three positions:

"1. With the patient lying on his back and the plate behind him—this gives the best conception of the topographical relation of the coils of small bowel to each other and to the large bowel. In stout people, however, and in patients in whom there is as yet little distention, the presence of abnormal gas accumulations may be missed.

"2. With the patient lying on his abdomen and the plate beneath him—this position gives the sharpest definition of intra-intestinal gas and bowel outline. Its disadvantage is that dilated loops of small bowel may be displaced into the flanks by the pressure against the central portion of the abdomen interfering in the differentiation between colon and small bowel.

"3. With the patient in the erect posture—this will permit the demonstration of fluid levels in the bowel by causing the gaseous contents to rise on top of the liquid contents. In patients too sick to sit up Ochsner's suggestion of taking plates with the patient lying on his side with the plate against his abdomen has proven satisfactory.

"The plates should be taken before the administration of enema or irrigation of the colon for the following reasons: In the first place the gas which may be present in the colon may be expelled, and a wrong conception of the type of gas distributed obtained. In the second place if the plate is taken too soon after the irrigation, retained fluid and gas introduced by it may not be completely absorbed or expelled, and may give rise to small fluid levels in the colonic saccules."

Volvulus of the sigmoid is a closed loop obstruction, not necessarily complete, in which there can be little escape of gas and little absorption because of the disturbed blood supply to the involved bowel. As a result the distention of the sigmoid is far greater than that seen in other types of intestinal obstruction. We refer to the characteristic roentgenologic feature on the plain film as being the "bent inner-tube." It consists of two more or less vertical arms, ascending and descending, lying adjacent to one another filled with fluid and gas and reaching to the liver on the right or the diaphragm on the left. The diameter of an arm is far greater than the diameter of any other distended loop on the film. The two arms are usually equal in diameter but due to the obliquity of the film one may appear larger than the other. The distention often reaches such proportions that the complete outline of the "bent inner-tube" may not be visible on one film. By taking roentgenograms in three positions as described it is usually possible to outline the "inner-tube" effect.

Several other features on the plain film may help to confirm the diagnosis: (1) The presence of a fluid level in each of the two loops on the film taken in the erect position. This may not be clearly made out because of the presence of multiple fluid levels as seen in any intestinal obstruction. In some cases loops of small bowel may become adherent to the volvulus and become obstructed with visualization of fluid levels and dilatations on the film. (2) The descending, transverse and ascending colon are usually greatly distended but the distention does not reach the proportion of that in the sigmoid and is distinguishable from the arms of the volvulus by the

relative position of the loops. (3) The use of contrast media may demonstrate the twist but if the volvulus is complete no barium will enter the loops of sigmoid.

THERAPY

The simple untwisting of the volvulus at operation and the insertion of a rectal tube per anum is the procedure of choice if the gut has not become gangrenous. The proper passage of the rectal tube permits the immediate deflation of the tremendously distended loop allowing the escape of the great accumulation of gas and fecal material. If the twisted loop has become gangrenous as occurred in one of our cases, an exteriorization procedure or obstructive resection should be performed. A variety of surgical procedures for the relief of acute volvulus and the cure of recurrent volvulus has been proposed and described in the literature. Hyman[9] has relieved recurrent attacks of volvulus by placing the patient in the knee-chest position and passing a rectal tube through a large sigmoidoscope under direct vision. Considering the generally poor condition of these patients, we believe that they are best treated by the least complicated of surgical procedures. In the absence of gangrene we have had no fatality following simple untwisting of the obstructed loop after opening the abdomen. In the presence of a gangrenous sigmoid, an exteriorization procedure is rapid and comparatively safe. Recurrent sigmoid volvulus may be handled by any surgical procedure which has as its object the shortening of the redundant sigmoid and its mesentery. In general the surgical approach should aim to relieve the acute condition by an operative procedure which is least complicated and time-consuming. Even though this condition is subject to recurrence the patient's condition usually does not warrant more than an untwisting procedure. Sigmoid volvulus is a closed loop obstruction and will not be relieved by cecostomy or transverse colostomy.

CASE REPORTS

CASE I. M. G., Hospital No. 57511. A colored female, age thirty-nine years, was admitted on August 30, 1935, with a history of generalized colicky, abdominal pain of six days' duration associated with three episodes of vomiting. She had had no bowel movement for four days prior to admission with the passage of only small amounts of gas and had lost 20 pounds in the past three months. She had had previous episodes of abdominal pain and constipation of long duration relieved by cathartics and enemas.

The patient appeared to be a well developed colored female, not acutely ill looking. The abdomen was markedly distended and diffusely tender. A large soft mass could be palpated in the left lower quadrant of the abdomen. Rectal examination disclosed no abnormalities. Celiotomy was performed through a left lower abdominal muscle-splitting incision. A volvulus of the sigmoid was present with the twist at the rectosigmoid junction. The gut was tremendously dilated and appeared to occupy most of the peritoneal cavity. The sigmoid was delivered into the wound, the gut was untwisted and a rectal tube was inserted per anum with the expulsion of a large quantity of gas and fecal material. The deflated sigmoid was replaced in the peritoneal cavity and the abdomen was closed without drainage. The postoperative course was uneventful and the patient was discharged on the twentieth postoperative day.

CASE II. L. D., Harlem Hospital No. 61379. A colored male, age forty-nine, was admitted on December 11, 1935, with a history of generalized colicky abdominal pain of three days' duration associated with repeated vomiting. There had been no bowel movement or passage of gas since onset of the attack and no history of previous similar episodes. The patient appeared acutely ill and markedly dehydrated. The abdomen was markedly distended and tympanitic throughout. Generalized abdominal tenderness was present. Rectal examination disclosed no abnormalities. The patient was thought to have an obstruction of the left colon probably due to neoplasm. A cecostomy was performed through a McBurney incision but only a small amount of fecal material drained through the cecostomy tube. The plain films of the abdomen were seen on the following day by Dr. Snow who reported the presence of a

FIG. 1. Case III. Preoperative plain film of the abdomen taken in the upright position showing two huge vertical loops extending to the left diaphragm giving the typical "bent inner-tube" effect with ascending and descending arms. A double fluid level is seen but multiple fluid levels in the small and large bowel detract from the accuracy of this sign.

FIG. 2. Case IV. A cecostomy had been performed because of misinterpretation of the plain films and barium had been introduced through the cecostomy tube. Barium is shown in the cecum and ascending colon. Two huge vertical loops of sigmoid are clearly illustrated extending from the pelvis to the left diaphragm.

sigmoid volvulus. The patient was again removed to the operating room and a celiotomy was performed through a left lower abdominal muscle-splitting incision. A typical volvulus of the sigmoid was found with the twist counter-clockwise at the rectosigmoid junction. The serosa of the involved gut appeared hemorrhagic and black in areas along the antimesenteric border. The condition of the patient was extremely poor and resection was decided against. The sigmoid was delivered, untwisted and decompressed with a rectal tube. The abdomen was closed without drainage. In spite of supportive therapy the condition of the patient became progressively worse and died on the first postoperative day. Postmortem examination was not performed.

CASE III. W. D., Harlem Hospital No. 11146, a colored male, age thirty was admitted on April 17, 1939, with a history of inability to urinate for the twenty-four hours prior to admission, severe colicky, lower abdominal pain and vomiting of about forty-eight hours

duration. There had been no bowel movement nor passage of gas for the past forty-eight hours. Upon examination the patient appeared to be acutely ill. The temperature rose from 98.6° on admission to 104°F. in a few hours. The abdomen was markedly distended and tender throughout. No masses could be palpated in the abdomen. Rectal examination was negative. Examination of the plain films of the abdomen showed the presence of volvulus of the sigmoid colon. (Fig. 1.) Celiotomy was performed through a left lower abdominal muscle-splitting incision. A typical sigmoid volvulus was found with the twist at the rectosigmoid junction in a counter-clockwise manner. The involved sigmoid was gangrenous and about 250 cc. of brown, foul-smelling fluid was present in the peritoneal cavity. The involved gut was exteriorized and an obstructive resection performed. The peritoneal cavity was drained and the subcutaneous tissues were packed open with iodoform gauze. Following removal of the proximal Payr clamp, the colostomy drained well. In the next few days
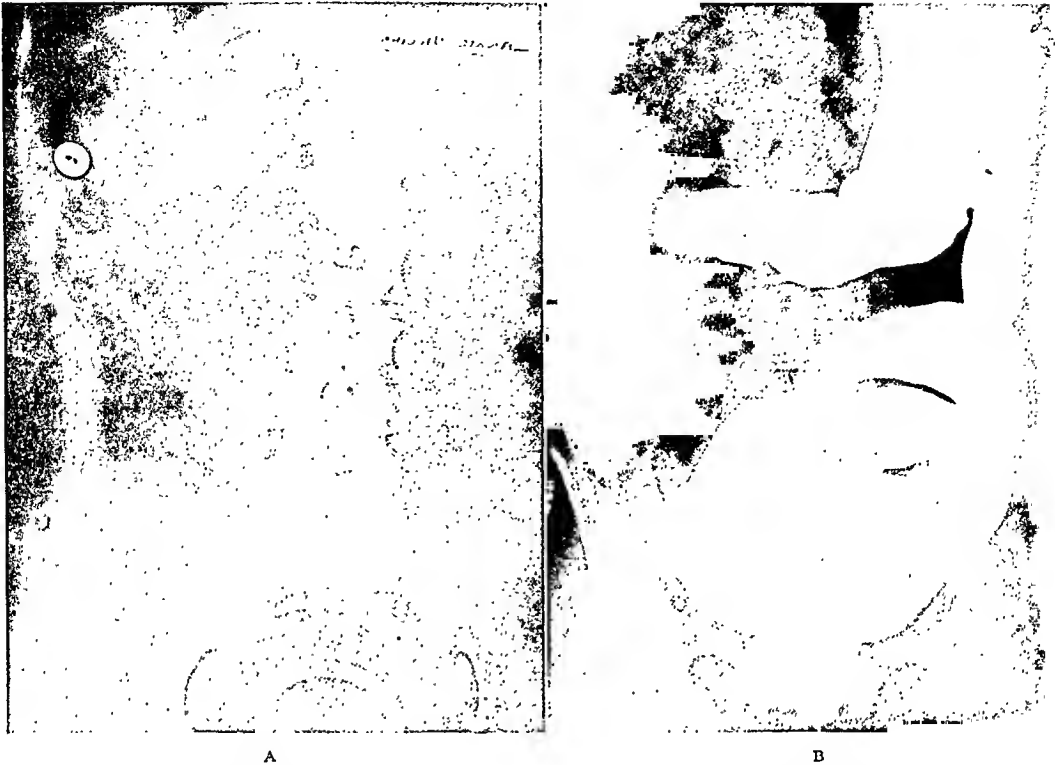
FIG. 3. Case V. A, preoperative plain film of the abdomen showing two tremendously distended loops of sigmoid oeeupying most of the field and lying in a slightly oblique manner. There is great distention of the descending and transverse colons. B, barium enema two months later showing tremendous elongation and redundancy of the pelvie eolon.

it became evident that a spreading peritonitis was present and a fatal outcome was to be expected. The patient died on the eleventh postoperative day.

CASE IV. F. W., Harlem Hospital No. 126988, a colored male, aged fifty-four, was admitted November 6, 1939, with a history of generalized colicky abdominal pain, obstipation and repeated vomiting of forty-eight hours' duration. The patient noted increasing distention of the abdomen and an inability to pass gas by rectum. There were no previous similar episodes. The patient had moderately severe hemoptyses on several occasions and had lost 20 pounds in the past year. Examination showed the patient to be acutely ill and dehydrated. The abdomen was markedly distended and loops of bowel were outlined on the abdominal wall. Peristaltic waves were visible on inspection. The abdomen was markedly tender throughout. No masses were palpable. Rectal examination disclosed no abnormalities. A Miller-Abbott tube was passed but without noticeable relief of the distention. An obstruction of the left colon was thought to be present, probably due to neo-

plasm. A cecostomy was performed through a McBurney incision. The cecum was tremendously dilated and further exploration was not possible. The plain films of the abdomen were reported by Dr. Snow on the following day to be typical of volvulus of the sigmoid. (Fig. 2.) X-ray films of the chest showed advance pulmonary tuberculosis. The cecostomy drained poorly and distention progressed. The patient refused further operative procedure and died on the second postoperative day.

CASE V. C. W., Harlem Hospital No. 151292, a colored female, aged twenty-two, was admitted January 22, 1941, with a history of severe generalized abdominal pain starting the day of admission. There was no nausea or vomiting. She had had a bowel movement in the morning and on the day prior to the attack. There was a history of a similar attack two years ago. No previous operative procedure was noted. The patient did not appear acutely ill or dehydrated. The abdomen was markedly distended and tympanitic. No masses or localized areas of tenderness were present. Rectal examination was negative. Plain films of the abdomen showed the typical appearance of

sigmoid volvulus. (Figs. 3A and B.) Celiotomy was performed through a left lower abdominal muscle-splitting incision. A volvulus of the sigmoid was present with a twist just above the rectosigmoid junction. The sigmoid was tremendously distended and appeared to occupy the entire abdomen extending to the right upper quadrant. The involved gut was delivered into the wound untwisted and decompressed with a rectal tube. The abdomen was closed in layers without drainage. The postoperative course was uneventful and the patient was discharged on the twelfth postoperative day symptom-free.

CASE VI. I. C., Harlem Hospital No. 151948, a colored female, aged forty-five, was admitted January 10, 1941, with a history of severe colicky para-umbical pain of four days' duration accompanied by marked abdominal distention. The patient vomited several times on the day prior to admission. She noted the passage of bright red blood by rectum two days prior to admission. There was no history of previous similar episodes. Paralysis of the right upper and lower extremities had been present for the past twenty years. Examination of the abdomen showed marked distention throughout, with moderate tenderness in the right lower quadrant. No localized masses were palpable. Examination of the lungs showed the presence of inspiratory rales at both apices and dullness at the right base. Clinically, the patient was thought to have an adynamic ileus following peritonitis. A Miller-Abbott tube was passed without relief of the distention. Plain films of the abdomen showed the presence of a sigmoid volvulus. (Fig. 4.) Celiotomy was performed through a left lower abdominal muscle splitting incision. A typical volvulus of the sigmoid was present with the sigmoid tremendously distended and reaching to the right upper quadrant. The twist had occurred about 8 inches above the rectosigmoid junction. The wall of the involved gut was discolored and the mesosigmoid was markedly thickened. The sigmoid was untwisted and deflated with a rectal tube. An obstructive resection of the involved loop was performed. Postoperatively the condition of the patient was good and following the removal of the proximal Payr clamp, the colostomy functioned well. On the fifth postoperative day the patient became aphasic and conjugate deviation of the eyes to the left was present. A spinal tap was performed and the fluid was found to be clear. The blood creatine, urea, and sugar were within normal limits. The blood Kahn was negative. The patient died on the sixth postoperative day. No postmortem examination was performed.

FIG. 4. Case VI. Plain film of the abdomen taken on admission showing typical "bent inner-tube" effect. Two enormous vertical loops of sigmoid are shown reaching to the left diaphragm. Markedly distended descending colon is present.

CASE VII. F. G., Harlem Hospital No. 155208, a Puerto Rican male, aged thirty-eight, was admitted April 19, 1941, with a history of generalized abdominal pain of four days duration. He had vomited several times on the day of admission and had no bowel movement since the onset. There had been a previous similar attack one year ago; there had been a right hernioplasty three years ago. The abdomen was markedly distended and tympanitic. A large firm, cystic-appearing elongated mass was noted in the left upper quadrant. No marked abdominal tenderness was present. Rectal examination was negative. The plain films of the abdomen showed the appearance typical of sigmoid volvulus. The patient was prepared for operation but while being given an enema, expelled tremendous quantities of gas and fecal material with immediate relief of
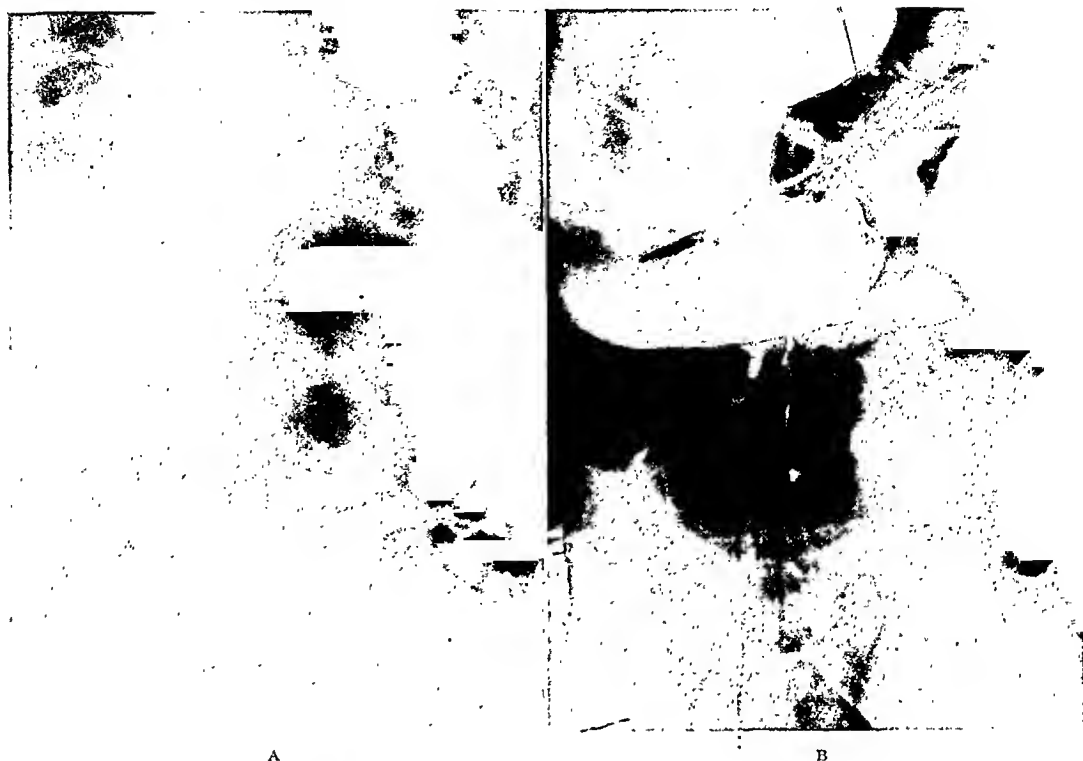
FIG. 5. Case VII. A, plain film of abdomen illustrating two vertical arms of the sigmoid extending to the left diaphragm. Marked distention of the small bowel is present. B, barium enema immediately following plain film showing constriction and twisting of the sigmoid loop in the region of the pelvis. The barium is shown to enter the lower loop of the volvulus and outlines the twist as an area of greatly increased density. The upper loop is partially filled with barium and the cecum is greatly distended.

abdominal pain and distention. The patient was discharged symptom-free. No operative procedure was undertaken.

CASE VIII. E. H., Harlem Hospital No. 159155, a colored male, aged fifty-six, was admitted first on June 21, 1941, and on a second admission in January 26, 1942. At the first admission the history was that of repeated episodes of obstipation and progressive abdominal distention for the past three months. The attacks were associated with severe paraumbilical pain and vomiting. The patient had no bowel movement for four days prior to admission. He complained of severe generalized abdominal pain and nausea. Upon examination the abdomen was markedly distended with loops of gut outlined on the abdominal wall. Following an enema, the patient expelled huge quantities of gas and fecal material, with immediate relief of pain and distention. The patient was discharged without operative intervention. On January 26, 1942, the patient was re-admitted with a history of three similar episodes since the last hospitalization, with relief obtained by enemas and catharsis. For

the past week he had complained of severe cramp-like abdominal pain localized in the left lower quadrant. There was associated nausea and abdominal distention. Upon examination the abdomen was found to be markedly distended with loops of bowel outlined on the abdominal wall and visible peristalsis. Plain films of the abdomen showed the appearance typical of sigmoid volvulus. (Figs. 5A and B.) Celiotomy was performed through a left lower abdominal muscle-splitting incision. A typical sigmoid volvulus was present with the sigmoid greatly distended and occupying most of the peritoneal cavity. The twist had a curve at the rectosigmoid junction, the torsion being clockwise for about 360 degrees. The involved loop was untwisted and deflated by rectal tube. The abdomen was closed in layers without drainage. The patient was discharged on the sixteenth postoperative day symptom-free.

SUMMARY AND CONCLUSIONS

Eight cases of acute sigmoid volvulus are presented from the surgical service of

Harlem Hospital. In all eight cases the diagnosis was made preoperatively by a correlation of the history, physical signs and the plain roentgenograms of the abdomen taken in the three positions suggested by one of us (L.G.). By direct examination of the patient alone it was impossible to differentiate this condition from other types of acute intestinal obstruction. The following points are emphasized:

1. In the presence of any acute intestinal obstruction it is highly important to consider the presence of volvulus of the sigmoid. It is most often mistaken for acute obstruction of the left colon due to new growths. It is to be remembered that the same principles of treatment do not apply to a sigmoid volvulus as to other obstructive lesions of the left colon because of the presence of an obstructed closed loop of bowel.

2. Plain roentgenograms of the abdomen clearly demonstrated the presence of sigmoid volvulus in all cases reported here. The characteristic "bent inner-tube" effect is demonstrated and other confirmatory x-ray features are pointed out.

3. The therapy for acute volvulus is immediate operation with the object of untwisting the obstructed loop and the insertion of a rectal tube for decompression. If the blood supply to the twisted loop has been compromised, an exteriorization procedure is indicated.

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DANGER OF PARAVERTEBRAL BLOCK IN THE THERAPY OF ACUTE FEMORO-ILIAC PHLEBITIS

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PHLEGMASIA alba dolens, or so-called milk leg, is a clinical entity with which almost everyone is familiar. Previously it was believed that the process began in the femoro-iliac region. Today, through further study and a careful postmortem dissection of the veins of the lower extremity, it has been demonstrated[1] that these veins are the initial starting points in the greatest percentage of cases. Since 1931 when Leriche[2] introduced the use of paravertebral procaine infiltration in the therapy of this condition, there have been many reports on the value of this method. Ochsner and DeBakey[3,4] popularized the use of paravertebral procaine infiltration for phlegmasia alba dolens in this country. While it has been established that this method is a definite adjunct in treatment, it is believed that this procedure is not without danger, for example, the propagation of a clot into the chest during the course of therapy.[5]

The purpose of this presentation is to illustrate the false security one may entertain with conservative measures in the therapy of acute femoro-iliac phlebitis. Heparin and dicumarol were given to one patient in conjunction with repeated procaine infiltrations of the lumbar ganglia.

Two patients were seen and treated with paravertebral lumbar procaine infiltrations. One patient was a thirty-five year old white female in whom painful edema of the left leg developed on the seventh postoperative day. The other patient was a fifty-eight year old white female who entered the hospital with acute large bowel obstruction and was treated with intubation and cecostomy. Pain and edema of the left leg developed on the third postoperative day. Both of these patients died and

autopsy revealed femoro-iliac phlebitis with upward extension.

CASE REPORTS

CASE I. I. S., No. 80358, a white female, was admitted to Grace Hospital on August 2, 1945, with a chief complaint of paralysis of the left leg and left arm. The patient enjoyed good health until one month before, when she noticed that she could not move a flatiron. Her left arm and left leg felt awkward. Several days later the left leg developed a prickling sensation. Two weeks later she suffered generalized headaches, spots before her eyes and vomited continuously. Her memory gradually and progressively became worse.

Upon admission physical examination disclosed a well developed white female lying quietly in bed. Her left arm was flexed and her left wrist was limp. She was well oriented as to time and place. Fundoscopic examination revealed bilateral choked disks, papilledema approximately grade III, a marked irregularity of the caliber of the vessels and a V-A ratio of 3:1. The patient could not move her left upper extremity; her left lower extremity was paralyzed from the hip downward. Her left foot was inverted and abducted. The patient was insensitive to light touch over the left side of the body and the knee jerks were increased on the left. The clinical impression at that time was a space-occupying lesion in the right parietal region, possibly a tumor, abscess or subdural hematoma.

The red blood count revealed a slight secondary anemia. White blood count, Kahn and Kline, and non-protein nitrogen were normal. Her temperature was 99.4°F., pulse 80 and respirations 18. X-rays of the chest and skull showed no disorder and spinal puncture revealed no abnormalities. An electro-encephalogram showed a depression of function in the right central zone with no evidence of a space-occupying lesion.

Penicillin was given and on the fourth hos-

pital day a right subtemporal craniotomy was done. Since there was a marked inflammatory process involving the spinal meninges over the right hemisphere, nothing further was done. On the seventh postoperative day pain and swelling developed in her left leg which was still paralyzed. On the ninth postoperative day, after surgical consultation, the clinical impression was femoro-iliac phlebitis. During the following ten days the patient received six 1 per cent procaine infiltrations of the left lumbar ganglia. The left lower extremity was clinically improved, swelling decreased and the pain was alleviated. On the twentieth postoperative day, while visiting with her husband, the patient developed a sudden pain in her chest and became cyanotic and comatose. Two hours later, having failed to respond to antispasmodic and stimulating drugs, the patient expired.

At autopsy the brain was normal except for many adhesions in the region of the right hemisphere. The right lung revealed a pulmonary infarct involving the lower lobe. There was a well fixed thrombus of the left femoral and external iliac veins. The thrombus extended into the left common iliac vein and up to the level of the renal veins in the inferior vena cava. The pathologic diagnosis was: (1) inflammatory meningeal reaction of the right temporal region of the brain; (2) femoro-iliac thrombophlebitis; (3) pulmonary embolism.

CASE II. M. L., No. 79393, a fifty-eight year old white female, was admitted to Grace Hospital with a chief complaint of abdominal cramps and vomiting of three days' duration. The patient was well until July 6, 1945, when she began to have severe abdominal pain. The next day she vomited and her abdomen became distended. She had no bowel movement since July 6th. She had no bowel irregularities nor noticed any blood in the stool. The past history was essentially negative.

Physical examination revealed a well developed, well nourished, obese female who appeared to be acutely ill. Her temperature was 99°F., pulse was 90 and respirations were normal. Her abdomen was markedly distended with moderate tenderness and increased auditory peristalsis in the right lower quadrant. Vaginal and rectal examinations were negative. The red blood count was 4.9 million, hemoglobin 17 Gm., white blood count 14,600 with a normal differential count. Urinalysis was negative.

The patient was treated with parenteral fluids and a long intestinal tube was introduced into the stomach but did not enter the small intestine. On the second hospital day a cecostomy was performed. On the third postoperative day, the patient complained of an aching sensation in the left leg. The leg became swollen from the knee downward, was cold to palpation and bluish grey in color. A paravertebral procaine block was done with subjective improvement. During the next eight days paravertebral block was performed six times. On the twelfth postoperative day the swelling increased and exploration of the left femoro-iliac region revealed much induration around the vein and the artery. Five days later the patient developed pain in the right leg. Homan's sign was positive. A diagnosis of deep thrombosis was made. Heparin and dicumarol were administered; 100 mg. of heparin were given intravenously and 300 mg. of dicumarol were given orally. Until the coagulation time had risen from slightly over two to fifteen minutes, 100 mg. of heparin were given every four hours. The following day the prothrombin report was 44 per cent of normal, therefore, an additional 100 mg. of dicumarol were given. Three days later the prothrombin level was 30 per cent of normal but the patient complained of pain in the lower abdomen. Both lower extremities were markedly edematous. There was tenderness below and above both inguinal ligaments in the region of the femoral vein. A diagnosis of rising thrombosis was made and the patient was taken to the operating room. A right transverse incision was made at the level of the umbilicus. The muscles were separated in the direction of their fibers and the peritoneum was retracted medially, exposing the inferior vena cava in which there was a palpable clot. It was not decided whether or not the clot had extended above the entrance of the renal veins into the inferior vena cava. The patient expired before any other manipulation was performed.

The essential findings at autopsy were: (1) adenocarcinoma grade II of the sigmoid colon; (2) thrombophlebitis involving both femoral and iliac veins with extension of the clot into the inferior vena cava above the level of the renal veins.

<center>COMMENTS</center>

The purpose of presenting these two deaths is to emphasize that femoro-iliac

phlebitis producing a white, swollen leg is a serious complication. If such patients are treated with anticoagulants and discouraged activity, they often show improvement but are not insured against pulmonary embolism.[6] Paravertebral procaine infiltration of the lumbar ganglia has proven effective in relieving pain and hastening the subsidence of edema in such cases. These two deaths are testimony to the fact that this method is not without danger. Because one is unaware of the pathologic process occurring in and around the vein, surgical intervention at the present time is the only positive method of preventing a clot from extending or breaking off and leading to a pulmonary embolus.

SUMMARY

Although the incidence of ascending clots from femoro-iliac phlebitis is not common, it is a serious condition.

The employment of paravertebral procaine lumbar blocks or dicumarol and heparin in the therapy of acute femoro-iliac phlebitis is not a safe guarantee that pulmonary embolism will be averted.

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TOTAL GASTRECTOMY FOR BENIGN GASTRIC ULCER

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ONLY in recent years has the operation of total gastrectomy been used with any great frequency. In the past the procedure was avoided because of the usually attendant high operative mortality, severe postoperative complications and the fear that the body activities could not function properly in the absence of the stomach.

At the present time reports indicate that the mortality rate and postoperative complications are definitely being lowered. This has been made possible by refinements in surgical technic and by experience gained in treating these patients postoperatively. Longmire[1] in his review of the literature notes that the mortality associated with the operation of total gastrectomy is approaching that of the operation of subtotal gastrectomy.

Most of the cases which have been reported were of extensive carcinomas of the stomach. The number of surviving patients after one year has been small. Therefore, the amount of information regarding the status of the gastrectomized patient is limited. Among the symptoms and signs which have been observed are those of nausea, vomiting, epigastric sensations of "fullness and burning," inability to eat heavily and difficulty in swallowing.[1,2,3] Nevertheless, it is apparent that these people can maintain themselves fairly well.

This case report deals with a patient who has been followed for one year after total gastrectomy. The pathologic features of the case and the course of the patient are informative.

CASE REPORT

Mrs. E. S., a white female, aged fifty-one, was admitted to St. John's Hospital because of abdominal pain. She stated that she had been well until one year prior to admission. At that time she began to suffer from epigastric pain and nausea. She went to her local physician who found nothing other than hypertension and treated her for this condition. Her symptoms became progressively more severe. Three months before hospital admission vomiting appeared. The vomitus was of undigested food which was colored with dark blood. Her stools at this time became tarry. The epigastric pain was sharp and constant. She had never had any previous serious illnesses. She had two normal children and had had a vaginal hysterectomy for a fibroid uterus at the age of forty-six. There was no history of diabetes, tuberculosis or malignancy in the family. She knew that she had lost a great deal of weight in the past year, "about 60 pounds."

Physical examination revealed a fairly well developed female who looked ill. Her skin lacked tone and she showed evidence of weight loss. Her temperature was 98°F., pulse 100 and respirations 20. The pupils were round and equal and reacted to light and accommodation. The sclera and conjunctiva were clear. The ears, nose and throat were essentially normal. Respirations were regular and rapid. Auscultation and percussion of the chest revealed no positive findings. The breasts were normal. The heart was of normal size. Rhythm was regular, and heart sounds were of good quality. No murmurs were present. Her blood pressure was 180/105. The abdomen was flat. No scars were present. There was moderate tenderness and a sense of fullness in the right upper quadrant. The liver and spleen were not palpable. The genitalia were normal and the extremities were essentially negative.

Urinalysis and the Wassermann reaction were negative. Blood chemistry was within normal limits. The erythrocyte count was 4,250,000; the leukocyte count was 13,800 with 75 per cent polymorphonuclears. Hemoglobin was 77 per cent of normal. The prothrombin time was normal.

On fluoroscopic examination it was found that the esophagus was normal in outline. The cardia of the stomach functioned normally. The gas bubble was normal in outline. A large ulcer crater was seen on the upper lesser curvature posteriorly. There was a meniscus

sign present. No peristalsis was seen in this area. The remainder of the stomach and duodenum were normal. Film examination confirmed the fluoroscopic findings. The conclusion was that of "stomach ulcer, probably malignant."

The patient was prepared for operation by blood transfusion, parenteral fluids and stomach lavages. The procedure was done under continuous spinal anesthesia.

At operation, an upper right rectus incision was used. The abdominal organs were found to lie in their normal relationships. No free fluid was present. On palpation the lower two-thirds of the stomach posterior wall was found to be invaded by hard, nodular tissue. At this site the stomach wall adhered firmly to the underlying pancreas. The greater omentum was studded throughout by small, firm nodules. On section these nodules were found to be composed of white, resilient tissue. The liver was normal in appearance. The impression was that of an extensive carcinoma of the stomach.

The stomach and the entire omentum were removed, and an anticolic esophagojejunostomy was done. Proximal to the anastomosis an entero-entero anastomosis was performed between the limbs of the jejunal loop. The abdomen was closed in layers.

During the first three days the patient received nothing by mouth. She had two blood transfusions and other appropriate parenteral fluids. Gentle suction was applied continuously to a Levin tube which had been passed to the anastomotic site.

The postoperative course was excellent. The temperature rose to 102°F. on the first day and then returned to normal on the fourth day where it remained until the patient left the hospital. On the fourth day the Levin tube was removed and the patient received small amounts of fluid by mouth. On the sixth day she was taking frequent feedings of small amounts of solid food with no associated discomfort. She was asymptomatic and had one to two normal bowel movements daily. She was discharged from the hospital fifteen days after operation.

Sectional study of the stomach revealed that the lesion was a benign gastric ulcer. This was surprising in the view of the fact that the stomach at time of operation had appeared to be so characteristic of carcinoma. The nodules of the omentum were inflammatory in nature.

For the first two months after leaving the hospital the patient found that she had to watch her diet carefully. She was unable to eat heavily or to drink fluids in any great volume. She had to take small sips of fluid and small bites of solid matter. If she did otherwise, she immediately became nauseous. She noticed no change in bowel habit.

After these first two months she found that she was able to accommodate a normal diet regimen. She was able to take fluids in any amount and frequency. She has been completely asymptomatic and is leading a normal life. A follow-up barium meal showed a moderately dilated jejunum and a normal appearing anastomotic stoma.

The patient has gained only about 15 pounds since leaving the hospital which is surprising when one considers that she has been eating exceedingly well.

This failure to gain weight following total gastrectomy has been also present in the series of gastrectomized patients that Longmire[1] observed.

Ferrous iron has not been given to this patient. Nevertheless, her blood values are within normal limits.

SUMMARY AND CONCLUSIONS

Total gastrectomy is recommended as an operation for extensive lesions of the stomach. The operation need not be accompanied by a prohibitive mortality rate. The gastrectomized patient is capable of adjusting himself remarkably well to his metabolic needs. Not all extensive invasive lesions of the stomach are malignant in nature.

A case is presented in which an apparently malignant lesion of the stomach turned out to be a benign gastric ulcer. The case is also noteworthy because of the smooth postoperative course and because of the ease with which the patient adjusted herself to the absence of her stomach.

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OMPHALOCELE WITH INCIDENTAL APPENDECTOMY*

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THE following case of a hernia operation on a baby less than an hour old is reported because of the immediacy of the operation, the incidental but necessary appendectomy and the successful outcome of the surgical procedure. Although no surgeon is likely to have a large group of such cases and conclusions are not possible from a single case, it is advisable to collate data from individual operations with the hope that ultimately the information may be significant. (Table 1.)

CASE REPORT

Baby L., No. 217513, a white male, was delivered at the Jewish Hospital with low forceps at 11:41 P.M. on September 27, 1945. His cord was immediately seen to be ballooned to form a sac extending 4 inches from the abdominal wall but it was of normal size from sac to placenta. The obstetrician clamped and cut the cord 3 inches from the apex of the sac. A sterile dressing was applied, the baby was weighed and placed in a heated crib. It was thought best to operate immediately because the stomach and intestines were as yet not distended with food and gas, suggesting that the abdominal opening might be closed with less difficulty.

Examination of the baby in the operating room showed that he had a true umbilical hernia. The hernial ring was small, 2 by 3 cm., and firm. The sheath of the hernial base was sharply defined from the surrounding abdominal skin. The sac was moist, thin, translucent and pliable and measured 8 by 5 cm. Numerous loops of bowel could be seen through the wall of the sac. The umbilical cord extended from the apex of the sac. When the cord was raised, the two umbilical arteries and the umbilical vein could be seen entering the abdominal wall in the left inferolateral area. The contents of the sac could not be completely reduced manually; part of the contents was adherent to the inner lining of the sac around the umbilical vessels. Rectal examination was negative.

The baby was strapped by towels to a circumcision board. Hot water bottles were placed about the infant. The operative field was prepared with ether and tincture of merthiolate and the area was draped. A sugar tit, moistened with whiskey, was used for anesthesia and gave satisfactory relaxation.

The sac was incised on the side opposite the umbilical vessels which easily could be seen and palpated. This portion of the sac consisted of peritoneum internally and amniotic membrane externally. The two layers were fused and made a delicate, thin wall which was less than 1 mm. in thickness. The incision was extended in both directions in an arc 1/4 inch distant from the hernial ring until the attachments of the bowel to the inner lining were encountered. The collapsed small intestine was returned with ease to the peritoneal cavity until the ileocecal region was reached. It was then seen that the inner mesenteric border of the cecum of the ascending colon and of the transverse colon up to but not including the splenic flexure was attached to the inner lining of the sac. The meso-appendix was similarly attached. All these structures were carefully freed from their attachments by sharp dissection. The meso-appendix, however, was so intimately connected with the peritoneum of the sac that in order to liberate it the appendicular artery had to be doubly ligated with quilting cotton and divided between ligatures. In replacing the large intestine into the peritoneal cavity it was necessary to make an incision, 5 mm. in length, extending vertically upward along the midline from the circumference of the ring.

Since it had been necessary to divide the appendicular artery, the appendix was again inspected five minutes after it had been returned to the peritoneal cavity. The appendix was turning black, hence an appendectomy was performed by ligating its base. Chemical

sterilization was not practiced since bacteria are not present in the intestines of a newborn for the first six hours. The edges of the hernial ring were freshened to obtain the strongest

The baby was last seen on December 24, 1948, three years after the operation. Examination at the site of operation showed no areas of weakness of the abdominal wall. The birth weight

TABLE I

APPENDECTOMY IN INFANTS LESS THAN ONE MONTH OLD

Author	Publication	Sex	Age	Symptoms, Diagnosis	Anatomic Lesions	Result
Lilienthal	*J. A. M. A.,* 51: 475, 1908	M	21 days	Hernia, tumor in right inguinal region; nausea, mass in serotum; abdomen swollen; rigidity	At operation gangrenous appendix was found in sae adherent, B. coli	Reeovery
Dixon	*Ann. Surg.,* 47: 57, 108	M	24 days	Strangulated inguinal hernia	At operation part of the ceeum, ileum and the appendix were found in hernial sac; appendix was adherent to the sac and gangrenous	Death
Reed	*J. A. M. A.,* 61: 199, 1913	?	2 hours	Disemboweled at birth; appendix red, contused and swollen	At operation the appendix removed and intestine replaeed	Reeovery
Ham	*Brit. M. J.,* 1: 1006, 1927	?	12 days	Scrotal hernia on right side	At operation hernial sae containing cecum and gangrenous appendix was found; appendix was removed	Recovery
Dune	*Khirurgiya,* 8: 139, 1937	?	18 days	Hernia	?—phlegmonous perforating	?
Bubis	*West. J. Surg.,* 50: 165, 1942	F	1 hour	Umbilical hernia, reduction impossible	At operation appendix and mesentery were adherent to hernial sac; appendix was removed	Recovery; died at eight months
Black and Waugh	*Proc. Staff. Meet., Mayo Clin.,* 17: 328, 1942	M	14 days	Right irreducible, inguinal hernia; skin over hernia red and warm	At operation gangrenous appendix was removed; abscess in sac alongside testicle; repair of hernia	Reeovery

postoperative healing of the wound. The muscle and fascia were not freed around the hernial ring.

The peritoneal surface of the fascia of the ring was closed with continuous No. oo chromic gut. The fascia was also closed, with little tension, using No. o chromic gut and the skin was approximated with interruptcd vertical mattress sutures of quilting cotton.

The baby's convalescence was excellent. He was breast fed for the first twenty-four hours and then had a supplemental house formula. On the fifth postoperative day the wound was seen to be healed and the skin sutures were removed. The baby was dischargcd from the hospital on the eighth postoperative day.

was 6 pounds 10 ounces and the present weight is 34 pounds.

CONCLUSION

This case is believed to be the earliest recorded case of removal of an appendix adherent to the hernial sac, with a favorable result. This result may be attributed to early surgical intervention.

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MECKEL'S DEFORMITY*

INTESTINAL OBSTRUCTION CAUSED BY A REMNANT OF VITELLO-INTESTINAL DUCT

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IN a previous paper the author[1] reported twelve cases of Meckel's diverticulum. In that paper special reference was made to seven patients who had a symptom complex suggestive of inflammation but at operation no signs of inflammation were found. In those seven cases of Meckel's diverticulum gastric mucosa was found in the diverticulum, and it was suggested that the symptoms the patients had were caused by acid and pepsin secreted by the ectopic gastric mucosa. The condition was termed "Dyspepsia Meckeli." Since that paper was published, the author has had two cases of Dyspepsia Meckeli in which gastric mucosa was found in the diverticulum and no inflammation was present. The author has now seen nine cases which fit the classification of Dyspepsia Meckeli. In addition to the cases just mentioned, the author has recently had an unusual case of Meckel's diverticulum which forms the basis of this paper. It is unusual because it represents a case of intestinal obstruction caused by a remnant of the mesentery of the vitello-intestinal duct rather than the diverticulum itself.

There are numerous deformities caused by remnants of the vitello-intestinal duct,[1] and the use of the term Meckel's diverticulum in reference to all of these deformities is misleading and confusing. In the case to be presented one would have difficulty classifying it as a Meckel's diverticulum, but the term Meckel's deformity would be entirely appropriate.

The following is the author's fifteenth case of Meckel's deformity:

CASE REPORT

Hospital Case No. 11,777, J. G. W., a white male, aged thirty-two, was admitted to the hospital at 2 A.M., May 26, 1946, complaining of pains in the abdomen. The history revealed that he became ill at 6 P.M. on May 25, 1946, with cramping pains in the abdomen. At first the pains were intermittent and mild but toward midnight they became rather constant and of intense severity. From the time of onset there was spasmodic intermittent nausea and vomiting. Upon arrival at the hospital the area of maximum pain was in the neighborhood of the umbilicus. The past history was entirely negative and irrelevant. He had always enjoyed excellent health. However, he admitted that all his life he had a phobia of appendicitis and was afraid all during his service in the navy that he would have an attack at some point where he could not obtain surgical attention. This fear was explained by the fact that his grandfather and his father both died of appendicitis with rupture and peritonitis.

Physical examination revealed a robust, muscular male, with a temperature of 98°F., the pulse rate was 78 and respirations were 20. His abdomen was moderately distended and tympanitic. There was meteorism to auscultation of the abdomen with the stethoscope. Palpation of the abdomen revealed distinct tenderness in the right lower abdomen at McBurney's point. There was rebound pain at this point. Rectal examination gave negative results.

Laboratory examinations revealed a total white blood cell count of 15,500, with 79 per cent polymorphonuclear cells and 21 per cent lymphocytes. Urinalysis was negative, the specific gravity was 1.025.

A diagnosis of probable appendicitis was made. This diagnosis was made with some

trepidation. Nevertheless, it was thought that a laparotomy should be performed without delay.

Operation was performed at 3:30 A.M. on May 26, 1946. A mid-transverse right Rocky-Davis incision was made under spinal anesthesia. Upon entering the abdominal cavity about 200 cc. of straw-colored, serous fluid was encountered. The appendix was found to be normal in appearance. The ileum was followed for about 20 cm., and a constricting band of tissue was encountered at this point. (Fig. 1.) The bowel was found to be rotated moderately in a state of volvulus at the point where the constricting band was found and had produced a complete intestinal obstruction. The bowel above this point was distended with gas and near the constricting band it was red and edematous. The bowel below this point was normal in every respect. After correcting the volvulus it was discovered that the constricting band was in reality a rudimentary mesentery with an artery and vein which completely encircled the bowel at that point. This band immobilized the bowel and accounted for the circumstances which allowed the volvulus to occur. The constricting band with its blood vessels was removed by sharp dissection. The lumen of the bowel which had been constricted by the band was found to be elastic, and a finger could be passed from side-to-side through the area, indicating that no permanent stricture existed. The omentum was placed over this area in an attempt to prevent post-operative adhesions at the site of dissection. The appendix was removed prophylactically. The incision was closed in layers without drains.

The patient's recovery was satisfactory until the following afternoon, May 27, 1946, when his abdomen became markedly distended and all signs of peristalsis disappeared. It was evident that an ileus had developed. A Miller-Abbott tube was inserted through the nose and advanced to a point where some of the abdominal distention was relieved. However, on the next evening of May 28th, it was believed that the distention was not being relieved adequately and the author was suspicious of a recurrence of the mechanical obstruction. Consequently, at 9 P.M. on May 28th the abdomen again was opened by a short left rectus incision using spinal anesthesia. The abdominal cavity was found to be dry. The bowel was not inflamed

and no mechanical obstruction could be found. The area of operation was entirely satisfactory. No adhesions existed. A state of paralytic ileus accounted for the abdominal distention. The Miller-Abbott tube was found to be in the jejunum, and the inflated tip of the tube was grasped with the hand and "milked" down

1A

1B
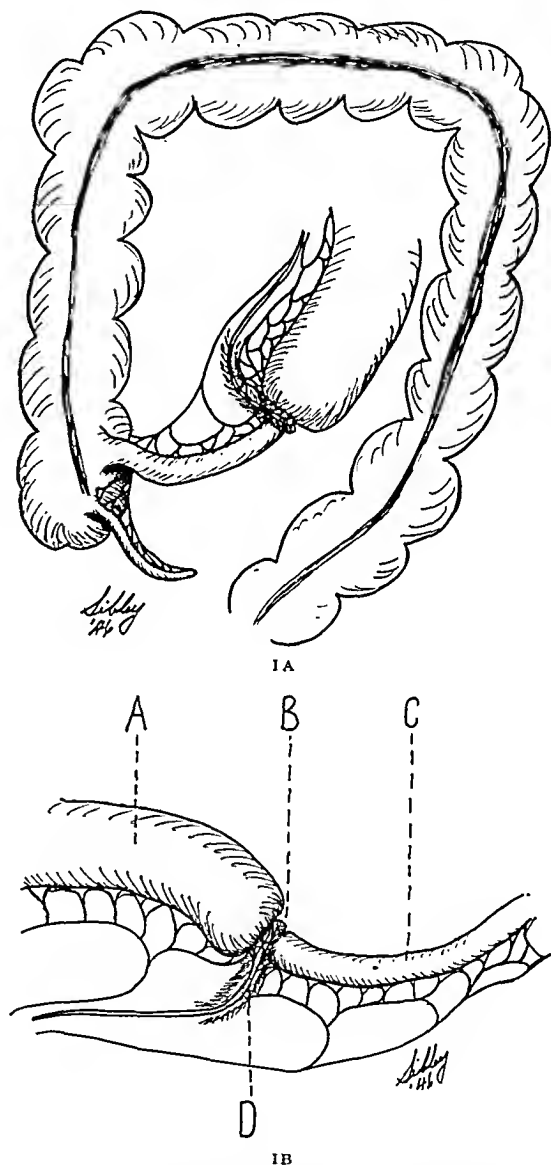
FIG. 1 A, schematic drawing of the intestinal obstruction caused by a remnant of the mesentery of a Meckel's diverticulum. B, a closer view of the intestinal obstruction· caused by the remnant of the Meckel's diverticulum. The individual blood vessels running up the mesentery can be seen clearly. A, distended ileum above the obstruction; B, remnant of the mesentery of Meckel's diverticulum causing obstruction; C, normal ileum below obstruction; D, blood supply of the mesentery of the Meckel's deformity.

into the ileum. During this manipulation the colon contracted and emptied itself through the anus, and the small bowel was deflated by the advancing Miller-Abbott tube. The incision was closed and the patient was returned from the operating room greatly improved. Following the program of early ambulation, the patient was gotten out of bed several times daily from the first day. Prostigmine was administered hypodermically every four hours and shortwave diathermy was applied to the abdomen each day for several days; enemas were administered twice daily. Nourishment was maintained by adequate amounts of intravenous solutions.

On June 1st gas was passing freely from the rectum; 2 ounces of castor oil were instilled in the bowel through the Miller-Abbott tube and the tube was removed. From this day on the patient had no further trouble. The bowels moved regularly, the abdomen remained undistended, both wounds healed by first intention and the patient was discharged from the hospital on June 6, 1946, eleven days after admission. Follow-up in September, 1946 revealed no recurrence of the symptoms.

SUMMARY

1. This case represents an unusual complication caused by remnants of the mesentery of the vitello-intestinal duct.

2. It is suggested that an over-all term, Meckel's deformity, be used to describe the diseases due to remnants of the vitello-intestinal duct whether they be a Meckel's diverticulum or otherwise.

REFERENCE

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CANCER, GUMMA AND TUBERCULOSIS OF THE FOREARM*

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THE nature of bony lesions in the forearm either primary or metastatic is often a diagnostic problem. This is especially true when such lesions are not associated with other pathologic processes. Although biopsy in this region can be done with ease, yet to make a clinical or x-ray diagnosis is considered mandatory. Such was the manifest interest in the cases herein presented.

In 1900 Mundell[1] reported three cases of tuberculosis of the wrist treated by bony excision, with good results. He stressed the fact that rarefaction in such bones is presumptive of tuberculosis. Stress, strain and friction were ventured as the mechanism for pain in such cases. Schurer[2] reported a case in which the disease was transmitted from the fifth metacarpus into the wrist joint in the absence of skin manifestations. His diagnosis was made by x-ray. Meusor[3] reported one case of tuberculosis of the wrist in which repeated x-rays were negative. Bony excision of the os naviculare effected a cure. F. de Faye[4] summed his experience in treating tuberculous osteomyelitis as follows: Spontaneous cure is apt to occur in children, and after bony excision in adults amputation is usually not necessary. In 1933 Denis[5] concluded that of the three approaches to rational therapy of tuberculous osteomyelitis, namely, heliotherapy, orthopedic or medical, and surgical, the surgical aspect had not received due credit. Steindler[6] discussed twenty-four cases of tuberculous osteomyelitis of the wrist joint and recommended resection or excision after a brief preliminary period of conservative treatment.

As evidence that many types of bony lesions may escape correct diagnosis, Meyerding[7] writes, "In some instances the surgeon and pathologist have found themselves in error in spite of their efforts and not until necropsy has the true nature of the lesion been discovered." In a treatise by Toumey[8] it was stressed that history of injury, trauma or illness along with other adjuncts may point directly to a specific diagnosis in bony lesions. Trauma as a cause of bony lesions or neoplastic growths is not generally accepted. However, Ritter[9] reported a case of neurogenic sarcoma of the forearm traceable to a five-week old injury, and acknowledged that in most instances trauma does not appear to play a role in such lesions.

Accidental and surgical trauma as a cause or localization of bony lesions has been both supported and denied. Wikle and Ritzmann[10] reported on surgery of a low-grade malignant adenomatous goiter with subsequent rapid growth of the remaining elements. It is true that a bony lesion at surgery may show one microscopic picture and an entirely different one of the metastatic lesions at necropsy. This has been shown in the osteogenic group of sarcomas. Trauma as a cause of delayed metastases has some supporters. Rash and Raider[11] reported on sixty-four cases of carcinoma of the thyroid. There was no forearm metastasis. One of the cases developed metastasis sixteen years after surgery. Outerbridge[12] recently reported on five thyroids in which biopsies of the metastatic lesions appeared microscopically to be normal thyroid tissue. One of these metastatic lesions appeared in the radius. Stoloff[13] reported a case of osteogenic sarcoma of the forearm which he associated with a two-week old injury. Geschickter and Maserity[14] reported on seventy-six malignant thyroids, six of which presented

FIG. 1. Case 1. L. H. X-ray picture shows the bony lesion in the distal ulna and a soft tissue mass.

FIG. 2. Case 1. Microscopic picture (low power) of biopsy specimen showing giant cell tubercle and caseation.

FIG. 3. Case 1. The soft tissue mass was excised; the lesion in the ulna was curetted and packed with 2 Gm. of streptomycin.
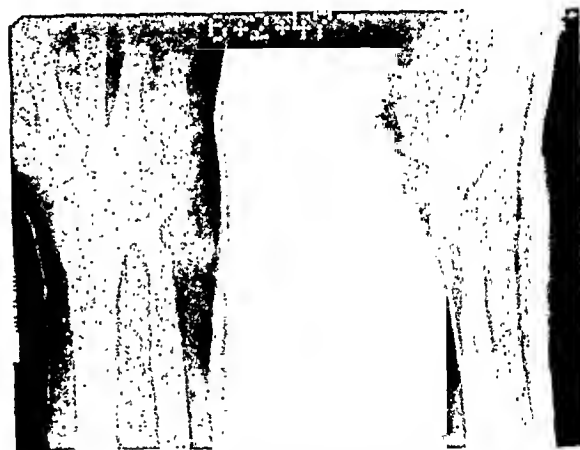
FIG. 4. Case 1. This film shows rounding off of the bony process with no x-ray evidence of progression of the lesion.

bony metastases, none of which was in the forearm.

Hodges[15] has stated that bony lesions react in a manner corresponding to the structure involved. Hence the diagnosis may be obscure when such lesions are seen in unusual places. He made specific reference to tuberculosis of long bones. Gumma of bones may react in a similar manner and thus may prove to be a diagnostic problem from the x-ray standpoint.

CASE REPORTS

CASE 1. L. H., a sixty-four year old female, entered Provident Hospital, November 22, 1946, with the chief complaint of pain with

swelling in the right forearm on the ulnar side proximal to the wrist joint. The symptoms began insidiously about one year previously, and during the twelve-month interval she had been treated by various means for arthritis. (Figs. 1 to 4.)

Examination revealed the distal ulnar region to be swollen and tender, and there appeared to be palpable discrete subcutaneous nodular masses. Except for a moderate hypertension the patient appeared to be normal.

Because of the history of one year's duration in symptoms, the right forearm and chest were x-rayed at the same time. A few calcified nodules in the chest were reported. There was an osteolytic lesion about 2 cm. in diameter in the distal end of the right ulna surrounded by a large, soft tissue mass. Chondrosarcoma and
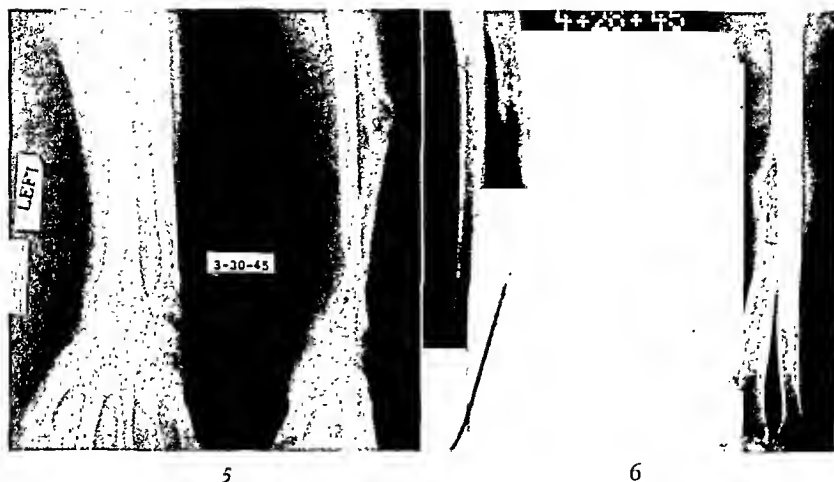
FIG. 5. Case 11. M. T. The lesion as it appeared in the radius when first seen.
FIG. 6. Case 11. This film shows defect in the lesion after biopsy.
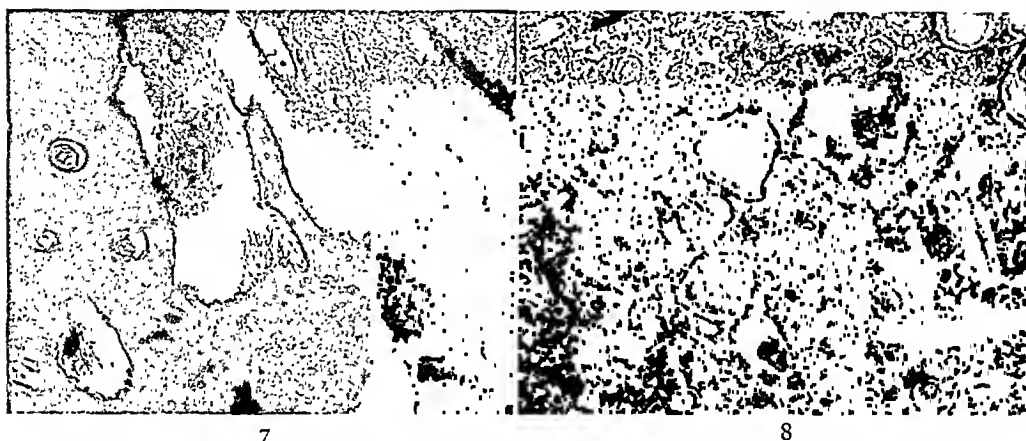
FIG. 7. Case 11. Low power microscopic section showed normal-appearing thyroid tissue in the bone.
FIG. 8. Case 11. The original thyroid sections as shown did not appear to be malignant.

tuberculosis were ventured as possible diagnoses although no calcium deposits appeared in the soft tissue mass. A biopsy was done November 24, 1946, which revealed a granulomatous tenosynovitis with granulomatous material in the medullary cavity of the distal ulna. The diagnosis of tuberculosis was confirmed microscopically.

On December 7, 1946, a wide excision of the granulomatous material including the medullary contents of the distal ulna was performed. The cavity was packed with 2 Gm. of streptomycin, closed tightly and immobilized in a posterior mold skin tight plaster cast. The patient received 1 Gm. of streptomycin daily for one week. The immediate postoperative condition of the patient was without incident, and she was discharged from the hospital on the eighth postoperative day. The patient has been followed in the out-patient department for clinical and x-ray observations at approxi-

mately monthly intervals. Clinically the lesion has been completely quiescent and x-rays showed no evidence of spread with rounding off of the bony defect following surgery. The cast was removed June 4, 1947, and at the present time the patient has no symptoms nor has there been any ankylosis at the wrist joint. There is no x-ray evidence of spread of the disease.

CASE 11. M. T., a sixty-two year old female, was admitted to Provident Hospital, May 7, 1945, with the chief complaint of pain and swelling in the left distal forearm, mainly on the radial side, of six months' duration. She allegedly injured this arm in December, 1944, and the symptoms grew progressively worse until entrance to the hospital. (Figs. 5 to 8.)

The past history revealed that the patient was operated upon by Dr. U. G. Dailey in October, 1942, for a large, nodular, mildly toxic goiter. The goiter history dated back twenty
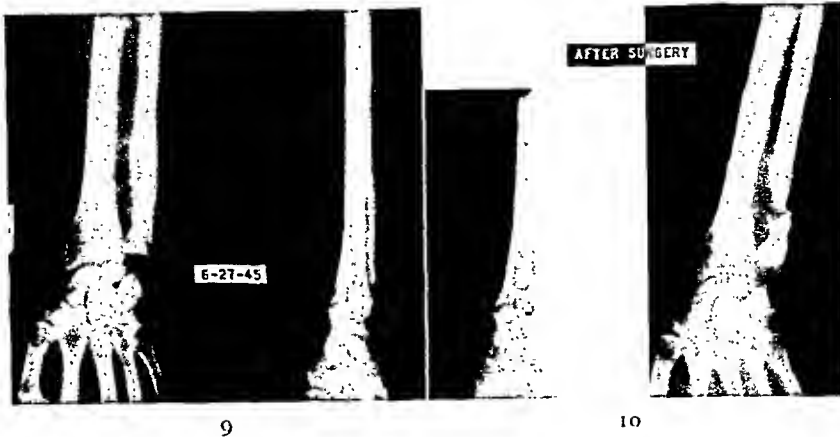
FIG. 9. Case III. A. M. The lesion in the ulna as it appeared when the patient presented herself.
FIG. 10. Case III. This film was made immediately after excision. Note complete bony defect in ulna.

FIG. 11. Case III. Lower power microscopic section upon which a diagnosis of osteochrondrosarcoma was made.
FIG. 12. Case III. Microscopic section upon which diagnosis of gumma was made. Note new bone growth and granular caseous material.

years. It was suggested by the surgeon at the time of operation that the goiter might be malignant, however, microscopic studies did not support such a diagnosis.

X-ray studies of the forearm revealed an osteolytic lesion of the radius. A metastatic lesion from the thyroid, parathyroid or kidney were considered unlikely because of inability to find obvious primary lesions at these sites. A clinical diagnosis of Ewing's sarcoma or endothelioma was entertained although x-rays did not show the "onion peel" effect. Biopsy of the radius was done May 8, 1945. Hemorrhage in the operative site was controlled only after packing the defect with bone wax (gelatin sponge and oxycel were not available at that time.) The immediate postoperative recovery was excellent. Microscopic examination showed what appeared to be typically normal thyroid tissue without evidence of mitotic figures or anaplasia. Further x-ray studies revealed osteolytic lesions generalized in the bony skeleton, more pronounced in the ribs. The patient was discharged from the hospital May 17, 1945, to be followed in the clinic. She was readmitted to the hospital October 3, 1945, in a terminal state, and expired October 8, 1945. Necropsy revealed generalized metastatic thyroid tissue.

CASE III. A. M., a fifty-two year old female, was admitted to Provident Hospital, June 22, 1945, with the chief complaint of swelling over the left distal ulna and weakness in the wrist. There were associated aches and pains mostly at night. The symptoms began four to five months prior to admission and grew progressively worse. (Figs. 9 to 15.)

Physical examination at that time revealed
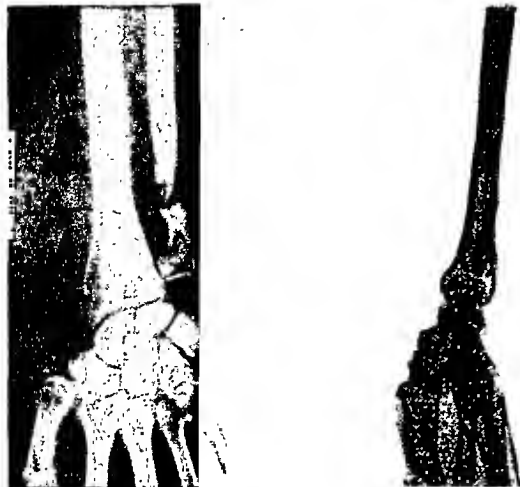
FIG. 13. Case III. Shows healing of the bony lesion after antiluetic therapy.

FIG. 14. Case III. Film made on June 3, 1947, which shows that only a small defect remains in the ulna.

an indurated swollen left forearm near the wrist joint. There was no fluctuation or heat. X-ray of the left forearm revealed an osteolytic lesion of the ulna. A positive serology was the only significant laboratory finding. A clinical diagnosis of bone sarcoma was made. Because of the patient's refusal for surgical intervention at that time, x-ray therapy was considered second choice and was given elsewhere. There was no improvement in the symptoms or x-ray appearance of the lesion. The patient returned to Provident Hospital, November 23, 1945, and submitted to further diagnostic procedures. Removal of bony and cartilage-like material from the entire cross section of the distal ulna

FIG. 15. Case III. The original liver biopsy in 1939 reveals loss of liver architecture with caseation and small round cell infiltrations. The size of the liver receded under antiluetic therapy.

and its immediate environs was done. A microscopic diagnosis of osteochondrosarcoma was made. The patient refused amputation and was not seen for several weeks when she returned requesting further antiluetic therapy which she had received intermittently for a number of years in our clinic. While following this patient in the Tumor Clinic, it was observed that the lesion began to heal.

A study of her previous record revealed that in 1939 she had an attack of nausea, vomiting and an abdominal mass was palpable. A cystoscopic examination was done and a slight right hydronephrosis was found. An exploratory laparotomy December 2, 1939, revealed a large, nodular liver, which according to the surgeon was carcinoma. The microscopic diagnosis was reported by the pathologist to be tuberculosis.

In view of the conflicting opinions as to the diagnosis and in view of the fact that further questioning of the patient disclosed that after these various complaints she would resume her blood treatments and feel much better, the original diagnoses were observed with some doubt. According to the record she had been most uncooperative with her antiluetic therapy appointments, hence she was never completely treated. A recheck of the microscopic sections

revealed the 1939 biopsy of the liver to be gumma, and the 1945 biopsy of the ulna was also gumma. Careful observation of this patient revealed that all symptoms disappeared and the bony lesion healed under potassium iodide therapy.

COMMENTS

To date there appears to be a paucity of data on the immediate and prolonged observations with the use of streptomycin combined with surgery in the treatment of tuberculosis of bones and joints. Evaluation of results are not easy since the series are usually small. Good, indifferent and bad results have been obtained on heliotherapy, orthopedic or medicine, and surgery, either combined or alone. However, an excellent result in one case would appear to merit some note, especially since the surgical procedure combined with streptomycin was used. Most authors have presented cases involving the carpal bones of the wrist joint. Few have discussed the original focus as being in the distal ulna or radius extending into the wrist joint.

How one may classify metastatic thyroid to bone as true cancer when microscopically the cells appear to be innocent is of interest. Although our case at thyroidectomy did not appear to show any microscopic evidence of mitoses or anaplasia, yet malignancy was suspected by the surgeon, Dr. U. G. Dailey, as evidenced by his notes. Hemorrhage at the time of biopsy of the left ulna was clinical evidence that the thyroid might have been at fault. Microscopically this proved to be the case.

A surgical and clinical diagnosis of carcinoma of the liver and microscopic diagnosis of tuberculosis of the liver were made in 1939. A diagnosis of osteochondrosarcoma of the left ulna was made in 1945. Such diagnoses made one investigate previous records resulting in the present diagnosis of gumma of both the liver and the left ulna.

SUMMARY

1. Three cases of osseous lesions in the orearm with the contending diagnostic problems of tuberculosis, metastatic thyroid and gumma have been presented.

2. The eventual management and treatment have been outlined with results obtained.

3. Emphasis is placed on the importance of x-ray, history and accurate observations in attempting a clinical diagnosis.

4. Although the x-ray is no doubt our best clinical diagnostic aid, yet bony lesions may present unusual configurations which may be misleading to the best roentgenologists.

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LONG ISLAND COLLEGE OF MEDICINE

Brooklyn

THE Long Island College of Medicine is a seventeen-year old institution with an eighty-eight year heritage. Although the college was incorporated in 1930, it stemmed directly from the former Medical College of The Long Island College Hospital which was chartered in 1857. The announcement of the first course of lectures, which began in March, 1860, stressed that this was the first medical college in the country organized in connection with a college or teaching hospital.

On December 15, 1888, the Hoagland Laboratory was formally opened; the first director was Dr. George M. Sternberg. This was the first laboratory in the United States, endowed by private funds, to be devoted to research in bacteriology and allied sciences. In 1896 the Polhemus Memorial Clinic was built and endowed by the late Mrs. Caroline H. Polhemus in memory of her husband, Henry D. Polhemus. By 1930 a very considerable amount of clinical training of students was being given in various affiliated Brooklyn hospitals by physicians who had no association with the parent hospital. It was, therefore, deemed wise to place the control of the college in a board of trustees independent of any one hospital but closely cooperating with several. This was done and the Long Island College of Medicine was duly incorporated in June, 1930.

In 1931 the Science Laboratory of The Long Island College Hospital was formally opened, a building made possible by a gift of Dr. John O. Polak, Professor of Obstetrics and Gynecology. In 1933 the Donnellon Student Center was established through a gift from Miss Jennie A. Donnellon and Miss Cornelia E. Donnellon. Adjoining the Science Laboratory, the house contains rooms used for student relaxation, social affairs and study. It also contains the "Open Gate," a cafeteria which affords dining facilities for the college and hospital staffs, students and visiting friends. In 1944 the William Alanson White Clinic was dedicated, a building which houses the Department of Psychiatry as well as the Social Service Department.

The course offered by the Long Island College of Medicine aims to integrate medical education and medical practice, to train the student to treat the human being as a whole in his particular relationship to the social structure and to emphasize his responsibilities both to his profession and to the public.

The present endowments amount to about five million dollars. At this time a drive is in progress to raise $15,000,000 for new buildings and added endowments. Several acres of land have been purchased near the Kings County Hospital, where a great part of the clinical undergraduate teaching is done, on which will be built modern buildings.
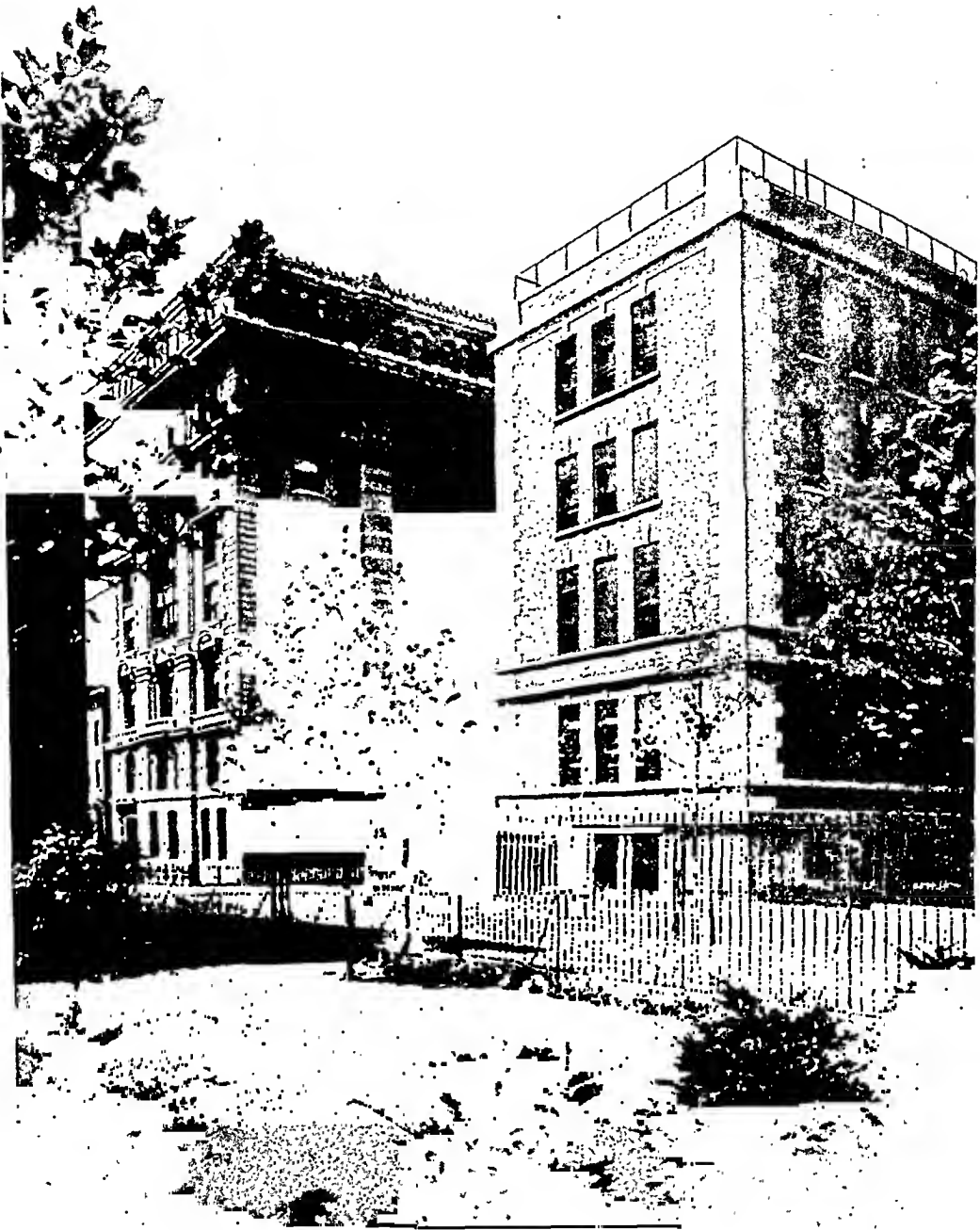
Long Island College of Medicine

New Instrument

NEW TRACTION DEVICE FOR REDUCING FOREARM AND WRIST FRACTURES AND DISLOCATIONS

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THE various fractures existing between elbow and wrist inclusive probably make up a high percentage of all fractures of the osseous system. Although some orthopedists do not consider them major fractures, these fractures will probably produce a higher percentage of unsatisfactory results than many others.

One prominent orthopedist remarked that "Colles's fractures are the ones we would like to send to our worst enemy," which would seem to bear out my remark regarding results. My own experience of nearly forty years bears this out.

The problem has been one of obtaining satisfactory reduction rather than maintaining reduction. In recent years we have found a simple, easy method of traction always to the point of distraction; and since we have followed that rule, we have found little or no trouble in maintaining position. Also, there is less soft tissue reaction because we produce no trauma and no additional bone damage that one gets by manual manipulations. The serrations (teeth) are not ground off, therefore greater assurance of maintenance of reduction. The old saying that "necessity is the mother of invention" was true with us in the preliminary work with the device herein described.

We had a complete posterior dislocation of the entire carpal group as the result of a motorcycle accident, among the many other injuries. Under anesthesia we attempted manual traction by four strong men to reduce the dislocation and we were not successful.

Some other method was necessary. Soft tissue damage by crushing and lacerations in addition to finger fractures prevented the use of a finger tractor. Also, the finger tractor involves an incorrect and undesirable factor, namely, that of constriction. The woven steel finger stalls exert a 100 per cent centripetal force, thereby dangerously constricting the finger and producing damaging nerve pressure. The amount of traction that can be obtained by finger pull (even with my improved equalizer, Fig. 1) is inadequate to overcome the strong muscles and ligaments of the forearm and wrist.

An hour or so in my machine shop resulted in the application of a new idea for traction. I placed a heavy encircling cast on the arm and elbow at right angles to use as an anchor-countertraction. For the tractor I made a hand (Fig. 1) from $\frac{3}{8}$ inch plywood and attached this to a $\frac{1}{4}$ inch round iron bar by two $\frac{6}{32}$ bolts. A heavy web strap completed the device.

The next day with the cast attached to the head of the Hawley table as an anchor, the board was placed on the hand and the web strap secured to the screw at the foot of the table under anesthesia. A few turns easily and completely reduced the dislocation to a wide distraction, without trauma to the damaged hand or effort by the operator. The individual bones of the carpus were widely distracted, all in their normal relationship.

Since that time I have used it on many Colles's fractures and allied bone injuries with the same success. Because of the keen
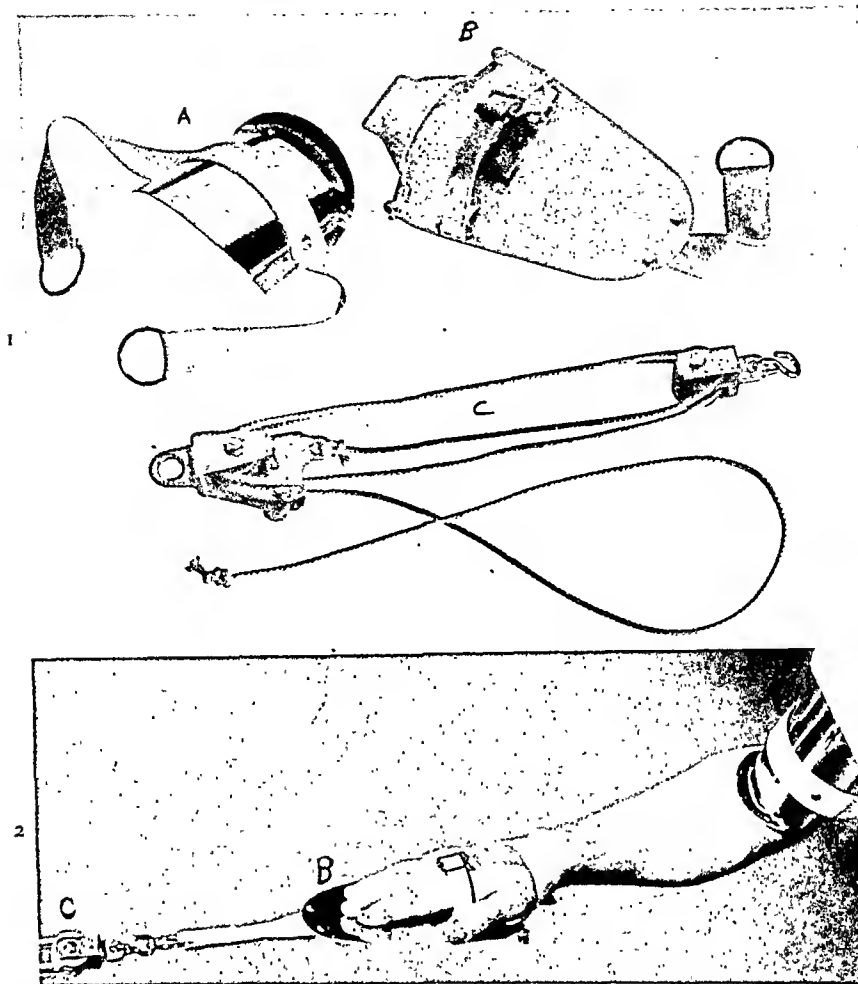
FIG. 1. Showing three parts of traction appliance. A, anchor or counter tractor; B, hand plate, traction strap and small finger strap; C, pulleys (tackle blocks) with self-locking device.

FIG. 2. Shows appliance attached to hand on a patient supine with his arm over the edge of the table. A, anchor attached to head of Hawley table or device on wall at table height; B, plate applied to the palm of the hand. Before pulling on the traction strap slide the plate well up on the hand; C, pulleys (tackle blocks) attached to the traction strap and to the opposite side of the room or to the foot of the post of the Hawley table. Keep the elbow at a right (90 degree) angle.

interest of many physicians and orthopedic surgeons, we carried the idea to our mechanics and the following appliance was developed:

DESCRIPTION AND TECHNIC

Place the patient on a flat table directly between two walls for anchor points. Place metal cuff to anchor arm at 90 degrees to forearm. This may be fastened to a doorknob by cotton rope. The metal plate is now applied to the palm with a strap across the wrist at the base of the thumb. One plate automatically fits all size hands, right or left. Push the plate well up and see that the strap is taut in the position before applying traction. The four-pulley ball-bearing "tackle blocks" are now attached to snap on the plate strap and the end of the pulley with locking device is attached to a radiator or door on the opposite side of the room. Under light anesthesia traction is now made, noting that the elbow is at right angles so the anchor cuff will not slip up on arm. The table may be moved footward to produce elbow at right angles. (Fig. 2.)
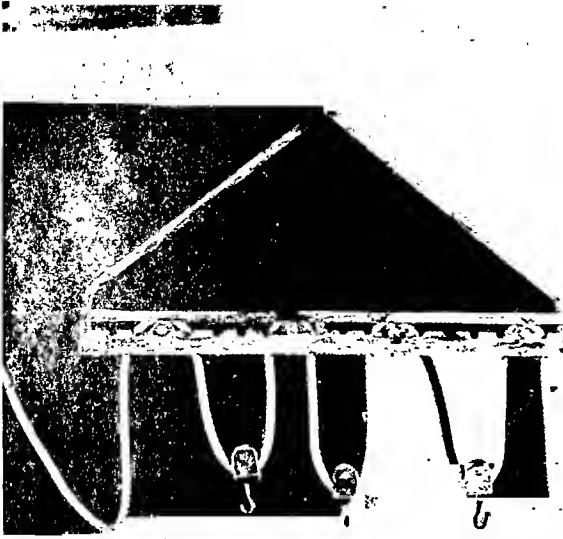
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FIG. 3. An improved equalizer made by the author. The pulleys in the bar are adjustable for spacing; the pulleys in the clevises reduce all cord friction to a minimum and real equalizer is obtained, which is not possible when the cord goes through the eyelets. This is suitable for finger and metacarpal fractures only and is not adequate for reducing arm fractures. Finger stalls will not stand traction up to 200 or 300 pounds.

FIG. 4. The first device made hurriedly by the author to meet an emergency. The fingers and thumb are not necessary as seen in Figures 1 and 2. The new metal device serves every requirement for traction of the arm and wrist.

From 50 to 300 pounds may be necessary to produce distraction of fragments. When crepitus at site of fracture is no longer felt, distraction has probably been accomplished and x-rays may now be taken. Traction is maintained while films are developed.

Hold fragments firmly with the thumb and fingers, loosen pulleys slowly and remove the plate. The serrations will engage and the fragments will have less tendency to slip. Apply splint or plaster; anatomic reductions and maintenance are to be expected. (Figs. 3 and 4.)

The advantages of this device are: (1) simplicity of application and use; (2) non-traumatic anchor; (3) no arterial compression in the hand or wrist; (4) no trauma to hand; (5) no discomfort by the tractor when using local anesthesia; (6) traction controlled to any degree, smooth, gradual and self-locking; (7) traction is maintained while x-rays are taken; (8) absence of palpable crepitus indicates distraction; (9) bone fragments are not further traumatized and serrations are intact; (10) device can be sterilized if surgery is indicated; (11) simplicity of removal for retaining appliance—cast or splint; (12) only known method of quick, easy and complete reduction of carpal fractures and dislocations by traction alone; (13) comminuted fragments have a tendency to "line up" if sufficient traction is obtained. (14) aluminum permits clear x-ray films and (15) one appliance fits all size hands, right or left.

Editorial

CARCINOMA OF THE LUNG

UNTIL recently the outlook for patients with lung carcinoma was hopeless. With the advent of intratracheal anesthesia the hazard of surgery of the open chest has been eliminated. The operative mortality now depends on the type of surgery rather than upon the physiologic disturbances resulting from uncontrolled respiration attendant upon an open pneumothorax.

Simple pneumonectomy, or the removal of a lung, for carcinoma is now a standardized procedure. Individual ligation of vessels at the hilum, with suturing of the bronchus and pleuralizing of the stump is the procedure now universally employed.

A tumor that has progressed into the mediastinum, either by direct extension or through involvement of regional lymph nodes, should be handled by block dissection of the mediastinum. This radical procedure is indicated when the disease has not been diagnosed early enough to permit early exploration. That this is worth while is attested by the five-year survival in about 6 per cent of cases with mediastinal involvement. Similarly, chest wall, pericardial or diaphragmatic involvement does not necessarily contraindicate resection. From the surgical standpoint, a more and more radical approach to the problem of lung carcinoma is to be advocated if a higher five-year survival is to be attained.

Frequently the diagnosis of carcinoma cannot be confirmed except at operation at which time the tumor may have progressed beyond the point of operability. It cannot be too strongly emphasized that carcinoma must be suspected before a diagnosis is made, and in many cases x-ray examination will afford the only means of suspecting the disease. An exploratory thoracotomy on the basis of a suspicious x-ray shadow in the absence of other evidence of malignancy will result in a higher incidence of cure than if operation is delayed until the diagnosis is established.

Peripherally situated tumors usually present no symptoms until they have undergone regional or distant metastasis. They may be discovered on routine chest x-ray examination. Bronchoscopy will reveal no mass to biopsy. Cases with completely negative bronchoscopy have a higher resectability rate (44 per cent) than those with suggestive bronchoscopy and negative biopsy (18 per cent) or with positive biopsy (36 per cent). Peripherally situated tumors are frequently of the adenocarcinoma type and as a rule metastasize through the blood stream rather than by way of the lymphatics. Because of their situation in the lung resection is more successful than in the case of the more centrally located tumors although the five-year

survival will depend upon the extent of the disease at the time of operation.

A tumor situated at the hilum, on the other hand, is likely to produce symptoms while it is still small in size. Bleeding is frequently noted and also wheezing due to partial blocking of the bronchus by the tumor. Recurrent episodes of "pneumonia," "slowly resolving" pneumonia, and pneumonia with central necrosis and abscess formation are characteristic of this type of carcinoma and represent various degrees of occlusion of the bronchus by the tumor with impairment of the blood supply.

X-ray examination will reveal a hilar shadow of increased density with peripheral obliteration of the lung distal to the blocked bronchus. Bronchoscopy will result in positive biopsy if the mass is in the main bronchus or in the secondary branch bronchi of the lower or middle lobe. Retrograde mirror bronchoscopy will be necessary to visualize tumors in the upper lobe, and these can be seen only when they are close to the mouth of the orifice. A tumor situated at the hilum but outside the bronchial tree will not be visualized directly, but may be suspected from the appearance of the bronchus adjacent to the tumor. Compression or invasion of the bronchus from without or widening of the spur as is seen in involvement of the carinal node suggests either direct extension or metastatic nodes.

Such tumors are usually either of the squamous cell or undifferentiated cell type. They may therefore be either the slow growing or the rapidly invading type of tumor. Initial spread will occur through the lymphatics. Because of the proximity of the tumor to vital structures such as the aorta, the superior vena cava and the heart, a slight extension of the process which may occur in a very short period of time may be sufficient to render the condition inoperable.

X-ray is of paramount importance in bringing peripheral tumors to operation because this may be the only means of diagnosis. In the case of hilar tumors serial x-ray pictures will reveal the progressive changes which distinguish carcinoma from other types of pulmonary suppuration. It should be remembered, however, that the feasibility of resection cannot be predicted by x-ray unless there is obvious metastasis beyond the thorax. Similarly, bronchoscopy, although of considerable importance, is only an adjunct to diagnosis. Sputum examination for malignant cells has recently been brought forward as another means of diagnosis prior to exploration. This method plays an important part in early diagnosis of malignancy, especially in those cases beyond the range of the bronchoscope, that are situated near the hilum. Peripheral tumors are less likely to have malignant cells in the bronchial washings, so that they should be explored with negative cell examination.

The responsibility of the medical profession, therefore, is obvious. First, the diagnosis of lung carcinoma should be suspected in order to bring the case to early operation. Secondly, the surgical approach should be as radical as extension of the disease will require.

ADRIAN LAMBERT, M.D.

Original Articles

ECTOPIC PREGNANCY*

I. WITH SPECIAL REFERENCE TO ABDOMINAL PREGNANCY

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ECTOPIC pregnancy, extra-uterine pregnancy or eccyesis is the existence of an embryo or fetus outside the uterine cavity. While the term "extra-uterine" is more commonly employed to signify this condition, the expression "ectopic," originated in 1873 by Robert Barnes, is the broader and more widely inclusive designation. It comprises those gestations where the ovum lodges and develops in the interstitial portion of the tube as well as all other gestations that develop in locations outside the body of the uterus. In this work the terms extra-uterine and ectopic will be used interchangeably. (Fig. 1.)

HISTORY

The subject of extra-uterine pregnancy is one of the most interesting in the entire realm of obstetrics. This type of gestation is not mentioned in the extant Greek and Roman medical literature. What is believed to be the first reference to abdominal pregnancy is found in that great rabbinical treasure-house, the Talmud. We read that the rabbis of the Talmud observed a child "which emerged from the abdominal side of the mother." They called the infant "Joze Dofan." In their opinion, such a child can be born alive and they "maintain that both mother and child survive in such cases" (Ploss, Bartels and Bartels).

Among the Buddhists we find mention of a "peculiar form of extra-uterine pregnancy outside the womb." According to their legend, the boy Buddha "was born through the right side or the armpit of his mother" (Köppen).

Abdominal pregnancy is of special historical interest because it was apparently the first type of extra-uterine gestation to be recognized.

Many years prior to 1717, when the first diagnosis of full term abdominal pregnancy was made by Robert Houston, lithopedions and abdominal fetuses had been observed and described. In fact the early history of extra-uterine pregnancy refers particularly to the operative removal of full term or long-retained secondary abdominal pregnancies.

Most writers attribute the first recorded case of intra-abdominal pregnancy to Albucasis (1013–1106), the distinguished Arabian physician of Cordova. His great work, "Al Tasrif," an encyclopedia of medicine, contains a treatise on surgery which is one of the best that has come down from the Middle Ages.

Albucasis describes the case of a pregnant woman whose fetus died without being expelled. The woman became pregnant again and the second fetus also died. At a later date an umbilical abscess developed with subsequent rupture and the expulsion of a "large number of small bones." The patient recovered but the fistulous tract remained (Ricci). This case affords an excellent example of an old, long-retained, secondary abdominal pregnancy.

Many other interesting examples of ectopic pregnancy are scattered throughout the early records. Schumann, in his monograph entitled "Extra-Uterine Pregnancy," refers to an interesting example of ectopic gestation known as the famous lithopedion of Sens. This was reported by Cordaeus in the early part of the sixteenth century and undoubtedly refers to the same patient mentioned by William Campbell in his treatise, "A Memoir on Extra-
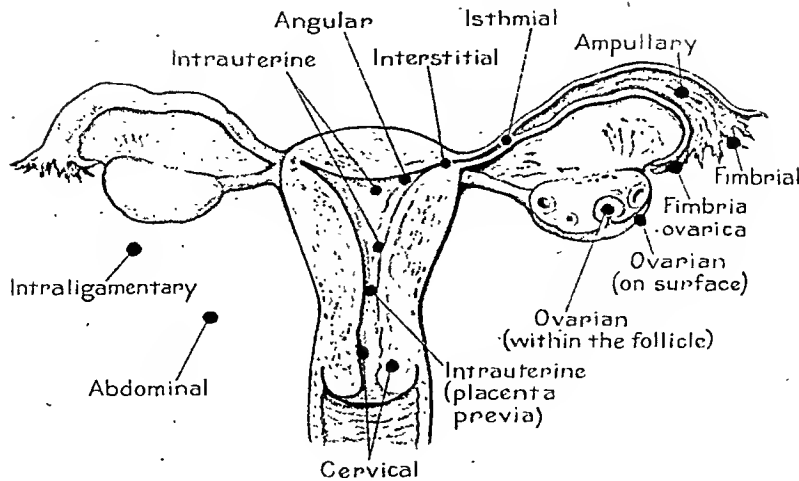
Fig. 1. Schematic drawing of coronal section through the uterus, left fallopian tube and left ovary indicating the possible sites of pregnancy.

Uterine Gestation." According to Campbell's account, the patient had been married many years but had remained sterile until the age of forty. When she died at the age of seventy-one years, a "foetus encased in a stoney crust" was removed.

Following are a number of other noteworthy cases presented by Campbell, among them being that of Cornax who "dilated an ulcer which formed near the umbilicus, and extracted a semi-putrid foetus, which had been retained for nearly five years."

Felix Platerus reports a case of a concubine from whose abdomen a semiputrid fetus was extracted. The patient survived the operation for one year.

In 1540, according to Donatus, Christopher Bain, a travelling surgeon, performed a laparotomy for the removal of a long-retained fetus. In all probability this operation was for ectopic gestation. It was successful and the patient recovered and shortly thereafter had other children born "in good condition."

In the latter part of the sixteenth century Horstius reported the case of a woman who, in 1563, had the remains of a fetus still in her abdomen where they had been since 1549.

James Primerose reported a classical case in which a patient conceived twice with extra-uterine pregnancies, the first occurring in 1591 and the second some time in 1594. According to Schumann, Primerose's work represents the earliest definite report of a laparotomy for the removal of an abdominal fetus. He states that "the cyst of the first child opened spon-

taneously through the abdominal wall. The fistula was enlarged, and this child extracted by Jacob Noierus, a surgeon." As this operation proved successful, the second infant was removed two months later by celiotomy.

Also reported in the sixteenth century (1560–1624) are the classical cases of Jacob Nufer and Christopher Bain. Boyce, who cites these cases, says that it is thought probable that Nufer performed the first abdominal section for extra-uterine pregnancy although his operation is considered as the first case of cesarean section on a living woman. The report appears in the collection of Caspar Bauhin and is recorded in Von Siebold's History of Obstetrics. "According to the relation of Caspar Bauhin, in his appendix to the Latin translation of Fr. Rousset's writings upon Cesarian section, Jacob Nufer, a swine-spayer, at Sigerhausen, in Switzerland, in the year 1500, delivered his own wife by opening the abdomen, and the operation proved successful for both mother and child."

Titus is of the opinion that many of the successful cesarean sections reported in the early literature were probably "crude laparotomies for the removal of secondary abdominal pregnancies."

What appears to be one of the earliest recorded cases of tubal gestation was recorded in 1604 by Riolanus the younger. The patient developed the classical symptoms of tubal rupture and died. An autopsy revealed that the right fallopian tube contained a fetus while the uterus appeared to be healthy and

normal. This author reports a similar case in 1638 where autopsy findings revealed a fetus in the left fallopian tube.

In 1669 Mauriceau presented plates and a painstaking description of a ruptured extra-uterine pregnancy which he had observed personally. Although his description of the case was excellent, his deductions concerning it gave rise to bitter controversy. He did not believe it to be a true tubal gestation but considered it to be a hernia from the right horn of the uterus. However, it was undoubtedly an extra-uterine gestation but whether it was tubal or interstitial is open to doubt.

The possibility of ovarian pregnancy was suggested as early as 1614. Most authors, however, attribute the first diagnosis of such a case to de St. Maurice in 1682. In 1899 Catherine van Tussenbroek published a histologic description of what is regarded as the first authentic case of ovarian pregnancy. This case demonstrated beyond question that the ovum could be embedded in the ovary.

The first record of simultaneous extra-uterine and intra-uterine pregnancy was that of Duverney in 1708 (Garrison). In his "Treatise of Midwifery," published by Pierre Dionis in 1718, we find the first clear description of interstitial pregnancy and a discussion of the cause of extra-uterine gestation. Of the cause of "foetus's form'd out of the womb" Dionis says: "If the egg is too big, or if the Diameter of the *Tuba Fallopiana* is too small, the Egg stops, and can get no farther, but shoots forth, and takes root there; and having the same Communication with the Blood-Vessels of the *Tuba*, that it would have had with *those* of the Womb, had it fallen into it, is nourished, and grows big to such a degree, that the Membrane of the *Tuba* being capable of no such Dilatation as that of the Uterus, breaks at last, and the *Foetus* falls into the Cavity of the *Abdomen*; where it sometimes lies dead for many Years, and at other times occasions the death of the Mother, by breaking open its Prison."

The author advances the belief "that it is most certain that Infants are form'd in the *Tuba,* as well as in the Womb." Dionis did not recognize salpingitis as a cause of tubal obstruction.

The first operation for extra-uterine pregnancy in America was recorded by John Bard of New York. He described the case in a letter dated December 25, 1759. The patient recovered.

William Baynham performed the second American operation in 1791 and also reported a similar operation which he performed in 1799. Both were cases of extra-uterine conception. The first was that of a fetus grown to full size and maturity which had been retained for more than ten years. In each instance the fetus was extracted successfully.

In the third operation of this type Charles McKnight was the surgeon. The case was reported by Mease of Philadelphia in 1795. According to Renner McKnight was the first to leave the placenta *in situ*. The operation was successful.

A remarkable operation for abdominal pregnancy was performed early in the nineteenth century by John King of South Carolina. King cut through the walls of the vagina and delivered the child by forceps, thus saving the lives of both mother and child (Welton, 1927).

The first American operation for "tragic" ruptured ectopic gestation was performed by Charles K. Briddon, of New York in 1883.

Early in the nineteenth century interest in the subject began to show a decided increase and a number of important monographs was published. In 1837 Dezeimeris published his outstanding classification in which he made a new arrangement of the various types of ectopic gestation and gave a careful description of the pathologic processes present. William Campbell's treatise, published in 1840, stands as a true landmark in the literature of the subject. In 1876 John S. Parry's excellent monograph, "Extra-Uterine Pregnancy," was published. Of this work Lawson Tait says: "It is at once remarkable for its scholarly research and fine critical sagacity." Parry collected 500 instances of extra-uterine pregnancy from various sources and his monograph is based upon an analysis of these cases. His work inspired particular interest in the pathology and treatment of extra-uterine pregnancy and represents a distinct forward step in an understanding and appreciation of this unfortunate accident.

In 1883 Robert Lawson Tait became the first to operate successfully for ruptured tubal pregnancy and to establish the operative technic for this condition. A pioneer in many phases of operative gynecology, Tait had been asked during the summer of 1881, to see a

patient whose condition had been diagnosed as that of tubal rupture with internal hemorrhage. It was suggested frankly that he "should open the abdomen and remove the ruptured tube." He agreed with the diagnosis but, nevertheless, he refused to operate; another hemorrhage proved fatal to the patient. Postmortem examination revealed that the diagnosis had been perfectly accurate. After injecting the excised specimen, Tait concluded that if he had tied the broad ligament and removed the ruptured tube, he could have arrested the hemorrhage and thus, in all probability, could have saved the patient.

In 1883 Tait did operate on a patient with a ruptured tubal pregnancy. Although the patient died, he attributed his failure to faulty technic. In spite of his keen disappointment in the fatal outcome he continued to operate for this condition and he lost but one of the next forty patients. Tait strongly advocated surgical intervention for extra-uterine gestations. As a result of his great ability and remarkable operative skill he enjoyed a high degree of success in his entire series of cases. In his "Lectures on Ectopic Pregnancy and Pelvic Haematocele," published in 1888, he presented a simple classification of ectopic pregnancies. He maintained that ovarian gestation was possible but had not been proved. While opinions differ widely on the site of implantation, a consensus of opinion on this aspect of the matter indicates that by far the greatest number of ectopic pregnancies is to be found in the tube. Tait says: "I believe that they are really all tubal, and in this consists the novelty of my views on the subject." He was of the opinion that interstitial ectopic pregnancy was very rare, "and that form which occupies the free part of the tube must have an overwhelming preponderance, and the other alleged forms I have yet to see."

Tait was the first to work out the pathology and treatment of pelvic hematocele. His lectures are classical and his views on this subject are generally accepted by the medical profession.

In 1891 Schauta demonstrated the importance of operative treatment. He compared 123 patients operated upon with 121 patients treated palliatively, with a mortality of 5.7 and 86.89 per cent, respectively. Because of the great improvement in operative procedures during this period, surgical treatment for ectopic pregnancy became better established and gradually took its place as the procedure of choice among many surgeons. Thus, many lives were saved that otherwise might have perished.

All authorities acknowledge the brilliant work of Werth whose pioneer investigations were published in 1887. His continued interest in this subject resulted in a further contribution in 1904 which became an outstanding part of von Winckel's "Handbuch." By way of tribute to Werth's distinguished work entitled "Beiträge zur Anatomie und zur Operativen Behandlung der Extrauterinschwangerschaft," Kelly comments: "The dawn of a new era in the critical examinations of the specimens dates from the work of Prof. Werth of Kiel." Anspach states that Werth's studies on ectopic pregnancy "embraced both the laboratory and the clinical side. His deductions and teachings have remained for the most part unchallenged."

COMPARATIVE ANATOMY

"Extrauterine pregnancy in domestic animals provides a highly confusing medley of truth and error," (Walter L. Williams).

Although it is generally admitted that this anomaly in domestic animals is possible, and while its occurrence has been recorded, a painstaking search of veterinary literature reveals that true ectopic gestation in animals is extremely rare and much less frequently encountered in them than in the human subject. The reasons for the rarity of this condition in animals may well include: (1) difference in mode of life; (2) restriction of generative organs to reproduction; (3) low incidence of disease, deformities and functional abnormalities in animals.

Our highly complex social order must receive a large share of the responsibility for the pelvic inflammatory diseases which play so important a role in ectopic gestation. Gonorrheal salpingitis and abortion are the most frequent offenders in this condition.

It may be assumed that the generative organs of animals serve but one purpose, that of reproduction. Coitus in animals is free from the use of contraceptive devices which in themselves may be a contributing factor in ectopic pregnancy. Animals are not subject to pelvic and abdominal surgical manipulations

similar to those which cause adhesions in the human female and interfere with the normal, unobstructed progress of the ovum to the uterus which may bring about extra-uterine implantation.

Campbell, in 1840, and George Fleming, in 1889, collected early references to extra-uterine pregnancies in animals. Campbell's cases date back to the sixteenth century and include a description of a cow "which conceived again during the retention of the extra-uterine calf . . . The bones . . . must have passed from the abdominal cavity, as it is not very likely that the animal would have conceived with a decomposed foetus in her uterus . . . Cases of this nature are recorded which occurred during the seventeenth century in a bitch . . . and in a sheep." This author states also that cases are recorded of extra-uterine pregnancy in a hare.

While tubal gestation is believed to be exceedingly rare in animals, Fleming cites several early investigators who refer to this anomalous condition. Rohlwes tells of having found fetal bones in an animal's left fallopian tube and Carus states that this type of pregnancy has been observed in the rabbit. Because the tube is incapable of distending sufficiently for the development of the fetus, Carsten Harms refers to tubal gestation as causing fatal internal hemorrhage by rupture of the tube.

Fleming's research would indicate also that ovarian implantation has seldom been observed although it is not at all impossible for it to occur in domestic animals. Rohlwes observed this rare form of gestation in a mare which had been pregnant twenty-one days. Plot noted it in a cow and in three sows. Fleming believes that interstitial gestation has not been noted in the lower animals but he states that abdominal pregnancy, while extremely rare, has been recorded.

Thiernesse reports an authenticated instance of simultaneous, normal uterine gestation and primary abdominal extra-uterine pregnancy in a sow. Details of this unusual case, including a pathologic report, were published in 1871 in *Annales de Méd. Vétérinaire de Bruxelles*.

In humans there are numerous cases recorded in which the fetus has been retained in the abdomen for many years. In animals also the fetus may be retained for long periods.

Simon reports the case of a ewe which had carried a dead fetal formation for two years; apparently this was a case of primary extra-uterine abdominal gestation. When the lamb was due to be delivered, the ewe experienced spurious labor. A veterinary made futile attempts to extract the fetus. For several days the mammary glands were enlarged and the ewe was sick and feverish. The symptoms disappeared gradually and the animal was restored to health. Two years later, much to the astonishment of the owner, the ewe brought forth a lamb, the product of a normal intra-uterine gestation. Shortly thereafter the ewe was butchered and the extra-uterine fetus was removed from the abdominal wall. This unusual case of compound pregnancy is interesting because its symptoms and course are identical with those in woman.

Several other cases of ectopic gestation in animals have been recorded including one of twin secondary abdominal pregnancy reported by S. Della-Rovère.

Bland-Sutton's important studies, completed in 1904, failed to disclose a single convincing record or specimen of tubal pregnancy but did report relatively frequent cases "in which puppies and kittens enclosed in tightly fitting sacs have been found adherent to the omentum and intestines."

Although some of these cases had been accepted by pathologists as primary abdominal pregnancies, Bland-Sutton designated them as "utero-abdominal pregnancies," and set forth his conclusions in a form yet to be disproved by subsequent writers. By dissection Bland-Sutton learned that rupture of the uterus was the major cause of abdominal pregnancy. He observed that in mammals with two-horned uteri each horn might contain several embryos. When these fetuses are too large to traverse the maternal passage, they may be extruded into the abdomen by reason of violent expulsive movements of the uterus, causing rupture of that organ.

Rabbits, cats and dogs are more susceptible to uterine rupture under these circumstances than are other animals. A somewhat tenuous analogy may be drawn between ectopic pregnancy in the fallopian tubes in women and cornual pregnancy in animals in that axial rotation may take place in each.

While the tubes apparently are the site of fertilization in lower animals and have been

suspected as the location of ectopic pregnancy by some writers, there are but a few recorded cases. Waldeyer reports an undoubted case of tubal pregnancy in an ape that died suddenly in the zoo and was dissected and examined very shortly after death. This is probably the best known case of tubal pregnancy in an animal. Other tubal pregnancies mentioned in the literature occurred in a cow and in a pig.

In 1898 Mandl and Schmit stated that they had observed ectopic pregnancies in the pig, dog, cow and horse. Most of these cases were believed to be secondary abdominal gestations.

Blair-Bell states that while primary ectopic pregnancies are of extreme rarity in animals, secondary abdominal gestations are fairly common, especially in hares and rabbits. He is of the opinion that such pregnancies are caused by the rupture of the uterine cornua, followed by the gradual extrusion of the fetus into the abdominal cavity. In some instances the placenta maintains its original site. He reports a case in a rabbit which he believes was an instance of primary abdominal pregnancy. After careful study of this case he concluded that primary abdominal implantation can take place in lower animals.

Tubal diverticula initiated by pathologic changes have been advanced as one of the causes of tubal pregnancy. Kök states that diverticula occur in 20 per cent of the tubes of swine. He believes, too, that mechanical disturbance in the transportation of the ovum is of etiologic significance in tubal pregnancies. However, he found only two cases of tubal pregnancy in swine reported in the literature.

According to Dorland and Bartelmez a study of mice and guinea pigs indicates that the decidual reaction begins to appear only after the developing ovum has corroded the superficial epithelial layers of the endometrium.

Tubal diverticula and the presence of favorable soil (decidual reaction) in the tube favor tubal implantation of a fertilized ovum not only in human beings but also in some animals.

Observations upon animals and humans would indicate that under normal conditions the spermatozoa gain access to the fallopian tubes promptly. Fertilization then takes place, usually in the outer third of the tube.

Kelly says that among lower animals fertilization of ova takes place in the tube, probably the upper part; the fertilized ovum is then carried to the uterus by the action of tubal cilia. In the presence of pathologic changes decidua may form and the ovum may become nested in the oviduct instead of the uterus.

In most animals, from the mouse to the cow, the time necessary for a fertilized ovum to pass from the ovary to the uterus is approximately three days. In the case of the monkey three days are required also and, according to Hartman, there is no reason why the process should take longer in the human subject.

Various estimates have been promulgated regarding the viability of the ovum and spermatozoon. In all probability the ovum perishes soon after it leaves the ovary. The life of the spermatozoon is extremely short in some animals while in others it may live for several months. It has been possible to keep human spermatozoa alive in test tubes for at least a week. If they remain in contact with vaginal secretions, however, they die within a few hours following coitus. On the other hand, they have been recovered from the uterus and tubes as long as two weeks after coitus.

Most authorities believe that the fertilized ovum is carried to the uterus by the ciliary current and also by means of peristaltic action of the tubal musculature. At the time the ovum is extruded from the graafian follicle, the fimbriated end of the tube assumes unusual activity and its cilia sweep the ovum into the ampullary portion of the tube whence it is propelled by peristaltic action to the uterus.

Working with rabbits and using corpus luteum hormone to stimulate decidual reaction, Fred L. Adair found decidua essential "before implantation can take place but it is doubtful whether decidua is necessary for implantation in the human." Attempts to cause the development of an ovum in a normal tube by ligating the uterine end immediately after fertilization have been unsuccessful for the most part.

While Walter L. Williams recognizes the possibility of primary extra-uterine pregnancy in animals, he is of the opinion that most cases of ectopic gestation are secondary implantations, the result of rupture of an intra-uterine nidation with concomitant fetal death. In cases of this type the veterinarian frequently observes a tear in the uterus, cervix or vagina, obviously the avenue of escape into the abdominal cavity. Usually these cases are the result of transverse uterine rupture caused by torsion.

INCIDENCE

During the fourteen-year period under study (1934–1947) the incidence of ectopic gestation in the Sydenham Hospital was as follows: Intra-uterine pregnancies 11,893; ectopic pregnancies 173; giving a ratio of 1:69; gynecologic admissions 7,726;* ectopic pregnancies 173; giving a ratio of 1:44; combined obstetric and gynecologic admissions 19,619; ectopic pregnancies 173; giving a ratio of 1:113.

According to Schumann, the corrected figures for the city of Philadelphia in the year 1918 read: Intra-uterine pregnancies 56,441; extra-uterine pregnancies 186; giving a ratio of 1:303.

In 3,747 ward cases at the Jefferson Hospital, Philadelphia, ectopic pregnancy was encountered eighty-three times, or once in forty-five cases.

Crossen and Crossen report an average incidence of approximately one ectopic pregnancy in every 200 cases of pregnancy and in about 2 per cent of gynecologic cases.

According to Stander of 34,356 obstetric cases reported from the New York Lying-In Hospital, 128 were ectopic pregnancies, giving an incidence of one ectopic in 268 pregnancies.

Nucci reports that in 31,783 obstetric cases in his series there was an incidence of one ectopic pregnancy for every 212 intra-uterine pregnancies or, roughly, a ratio of 1:200. This author reports that of 10,242 gynecologic admissions, 1.46 per cent was for ectopic pregnancy.

Age. Our patients ranged in age from sixteen to forty-five years as indicated in Table I.

TABLE I

Ages	No. of Cases	Per Cent
16–20	5	2.9
21–25	42	24.3
26–30	58	33.5
31–35	49	28.3
36–40	15	8.7
41–45	4	2.3
	173	100.0

The largest single age group was in the five-year period from twenty-six to thirty years of age in which there were fifty-eight cases

* Includes 173 cases of ectopic pregnancy.

(approximately 33.5 per cent). In the age groups from twenty-six to thirty-five there were 107 patients (62 per cent); 164 cases (95 per cent) occurred in the third and fourth decades.

In the series of 310 cases presented by Langman and Goldblatt, 292 (94 per cent) occurred during the third and fourth decades; 175 (56 per cent) occurred between the ages of twenty-five and thirty-five.

Marchetti et al. report 141 cases in which 135 (95.8 per cent) occurred during the third and fourth decades while eighty-two (58.2 per cent) ranged from twenty-five to thirty-four years of age. In Ware and Winn's study in 1941 of 150 consecutive cases 134 (89.3 per cent) occurred during the third and fourth decades and seventy-seven (51.3 per cent) between the ages of twenty-five and thirty-five. In Torpin's eighty cases, reported in 1944, seventy-five (94 per cent) occurred during the third and fourth decades and forty-one (51 per cent) ranged in age from twenty-five to thirty-four. Woodhouse reports seventy-three cases in which sixty-five (89 per cent) occurred during the third and fourth decades while thirty-eight (52.1 per cent) ranged from twenty-five to thirty-four years of age. In Schauffler and Wynia's sixty-five cases there were fifty-nine (91 per cent) in the third and fourth decades and twenty-seven (42 per cent) ranging in age from twenty-five to thirty-five.

Gravidity. Among the cases included in this series sixty-five patients had not been pregnant previously; 108 had been pregnant from one to eight times and there was a total of 391 pregnancies, including the present ectopic. The statistics in detail are presented in Table II.

TABLE II

Previous Pregnancies	No. of Patients	Per Cent
0	65	37.6
1	49	28.3
2	31	17.9
3	16	9.2
4	7	4.0
5	2	1.2
6	1	0.6
7	1	0.6
8	1	0.6
	173	100.0

Abortions. In this series the number of abortions is indicated in Table III.

TABLE III

Abortions	No. of Patients	Per Cent
0	118	68.2
1	42	24.2
2	10	5.8
3	1	0.6
5	1	0.6
6	1	0.6
	173	100.0

From the histories of the patients one gets the general impression that abortions, in all probability, were more numerous than these figures would indicate. However, it is always difficult to elicit a history of abortion. Many patients conceal this fact intentionally while others tend to forget it.

ETIOLOGY

The many generally accepted causes of ectopic gestation and the wide variation of the relative importance which leading authorities ascribe to them are adequate evidence of the uncertainty which surrounds the etiology of this subject and of the need for further energetic investigation. Especially striking is the marked divergence of opinion regarding the importance of what seem to be universally accepted causative factors. The opinions of individual investigators often seem to be strongly colored by personal experience, *i. e.*, the physician whose practice is composed almost exclusively of women from the wealthier social strata will not find salpingitis of gonorrheal origin a leading offender in his cases of ectopic pregnancy, whereas a man whose practice is of a heterogeneous urban character will consider tubal inflammatory disease of prime etiologic importance.

Sound anatomic and histologic study of the subject is impeded by hemorrhage and by the secondary changes that result from the growth of the ovum. These conditions obscure or obliterate the causes which existed at the time of the unnatural implantation. Despite this it is incumbent upon the surgeon to insist upon a searching pathologic report which will throw light on the causative factors in each case.

The four types of ectopic gestation, in order of frequency are: (1) tubal; (2) ovarian; (3) abdominal; (4) cervical. Tubal pregnancies far outnumber all the other types.

In reviewing the literature beginning with the contributions of Lawson Tait (1888), one is impressed by two observations made by the vast majority of workers. First, tubal implantation, the most frequent type of ectopic gestation, is caused by some factor, usually mechanical, which prevents the fertilized ovum from completing its passage through the tubal lumen to the uterine cavity. Second, this tubal barrier is frequently the result of pelvic inflammatory disease, often of gonorrheal origin.

Many authorities support the theory that pelvic inflammatory disease with its mechanical sequelae is a causative factor. Curtis says, "In the majority of instances the direct cause is a mechanical interference with the passage of the ovum," and he draws special attention to perisalpingitis and interstitial salpingitis which often follow instrumental abortion.

Kelly maintains that ectopic gestation is caused by obstruction to the passage of the fertilized ovum in the tubal lumen. He says, "Possibly the thickening of the tubal walls accompanying marked salpingitis facilitates the arrest of the ovum by interfering with the peristaltic movements and choking the lumen.

"Of still greater importance is the thickening and agglutination of mucosal folds serving to entrap the fertilized ovum during its tubal transit. Whatever explanation, chronic salpingitis undoubtedly does act as a prolific predisposing cause." (Figs. 2 to 8, Case II.)

Novak (1944) considers that factors which interfere with the transit of the ovum down the tube constitute the most important causes of ectopic gestation. He states that chronic salpingitis is the cause most often concerned because of its mechanical action in partially blocking the tube and because of its interference with ciliary activity and peristalsis. He says, "The egg does not implant itself until its burrowing apparatus, the trophoblast, has developed, and this normally takes place after the egg has reached the uterus. For this reason I believe the retardation of its progress is probably the chief factor in tubal pregnancy, permitting the development of the trophoblast while the egg is still in the tube."

Schumann maintains that the cause is some
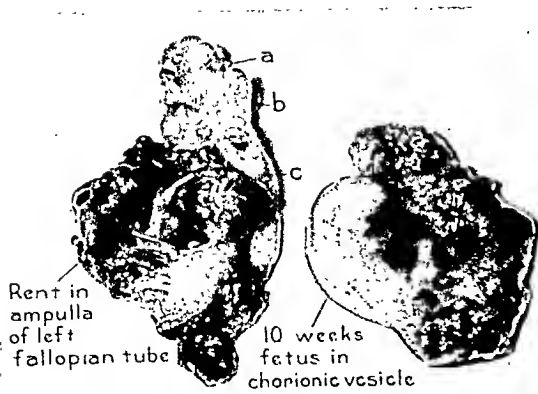
FIG. 2. Case II, J. M. A photograph of ruptured left tubal pregnancy measuring 6 by 3 by 0.5 cm. Approximately 2.5 cm. from the fimbriated end there is a rupture of the tube from which a fetus measuring 3 cm. in its chorionic vesicle was taken; menstrual age ten weeks.

interference with the descent of the ovum through the tube to the uterus. He believes that gonorrheal salpingitis is the factor most often encountered as an internal obstruction. ,

A histologic study was made of 129 of the 173 patients in this series with the following results: Acute salpingitis four cases (3.1 per cent); chronic salpingitis fifty cases (38.8 per cent); acute and chronic salpingitis fourteen cases (10.9 per cent); negative for salpingitis sixty-one cases (47.2 per cent). In forty-four patients who showed gross anatomic evidence of pregnancy, microscopic examination was not done because of wartime exigencies.

In his contribution to the etiology of ectopic gestation C. D. Williams states that at least 95 to 98 per cent of ectopic pregnancies are caused by diverticula, the sequelae of salpingitis. He says that every specimen which he examined microscopically from the gynecologic service of a large urban hospital revealed a bilateral, pre-existing inflammatory process.

In the majority of Polak's cases there was a history of previous inflammatory infection. Tyrone et al. in their study of 309 cases found salpingitis either grossly or microscopically in 37.5 per cent of the patients. In their statistics covering 141 cases of ectopic gestation in a large city hospital Marchetti et al. report a definite history of previous pelvic infection in 26.9 per cent. Langman and Goldblatt, in a study of 310 cases of ectopic pregnancy operated on in a large metropolitan hospital, report that less than 20 per cent had a history

FIG. 3. Case II, J. M. Photomicrograph, low magnification. Section was made through proximal end of tube (see *a* in Fig. 2). Shows chronic salpingitis; no decidual reaction; no chorionic villi.

of pelvic infection but microscopic examination raised the incidence to more than 50 per cent. Usually the inflammation was chronic. Burch and Seitchik found that patients quite commonly gave a history of some pelvic inflammatory disease or infection following labor or abortion or of infection following an operation for ruptured appendix.

In my series of cases either a clear or a suspected history of previous inflammation of the adnexae was evidenced. Many cases of chronic salpingitis were due to gonorrhea. In the study of any woman who has had an ectopic pregnancy one must not overlook the male partner since the ultimate cause may be an inapparent prostatitis or urethritis. Often these infections in the male were contracted many years previously. Thus, the history which the patient presents may lack the essential fact which provides the explanation. (Figs. 3 and 4, Case II.)

Some investigators ascribe little or no importance to pre-existing inflammation as a cause of ectopic pregnancy. Foskett found

FIG. 4. Case 11, J. M. Proximal end of tube, higher magnification of field shown in Figure 3.
FIG. 5. Case 11, J. M. Photomicrograph, low magnification. Sections taken from point nearer to ruptured portion of tube (see b in Fig. 2) showed decidual reaction.

FIG. 6. Case 11, J. M. Higher magnification of field shown in Figure 5.

that one-third of his series of 117 patients had had abortions. He believes that abortions and their sequelae are more important than venereal disease as causative factors.

A definite cause could be found in only about one-third of Oastler's series of 106 cases. Oastler believes that if a pre-existing inflamma-

tion were the only cause, the left side should have been the site of the greater number of pregnancies. However, he found about as many on the right side as on the left. Titus says " . . . purely mechanical interference has been shown . . . to be of doubtful etiologic importance." Less than 10 per cent of the specimens Litzenberg examined showed positive evidence of salpingitis when subjected to pathologic examination (1937). In a study of salpingitis as an etiologic factor in ectopic gestation Van Etten found that only 10.4 per cent of the cases observed in a large metropolitan hospital, "showed signs of previous or concurrent tubal inflammation." In Mac-Farlane and Sparling's series of 110 cases only 17.2 per cent gave a history of pelvic infection. Only eighteen of Tenney's 150 cases gave a past history of pelvic infection. He observes, " . . . but as that is a difficult history to obtain, I feel it fairer to rely on the pathological sections which show a much higher incidence."

Kerr is amazed not only by the absence of chronic salpingitis and appendicitis but by the absence of venereal disease. He admits, however, that a mild pelvic infection is probably the cause in the large majority of cases.

Another observation made by Tait which

Fig. 7. Case ii, J. M. Photomicrograph, low magnification. Section taken from the dilated and ruptured portion of tube (see c in Fig. 2) shows decidual reaction and chorionic villi partly buried in the wall and partly free in the lumen of the tube.

has been confirmed by subsequent workers is the occurrence of ectopic gestation in women who have experienced a period of protracted sterility associated with a pelvic inflammation following an earlier pregnancy. Tait remarks, "that a very large proportion of them [ectopic victims] have a history of prolonged sterility and menstrual suffering, showing that their procreative machinery was out of gear. Thus we often have the history common to tubal mischief that after a first labour there was an illness with marked symptoms of pelvic trouble, then a long period of sterility, then the ectopic gestation ending in rupture."

Beckwith Whitehouse, who supports gonorrheal salpingitis as a cause of ectopic pregnancy, directs attention to the infrequency of this condition in nulliparae and to its frequency after a long period of sterility which has been preceded by an adnexal infection.

Kelly states that women who have had pelvic inflammatory disease followed by a period of sterility may develop an ectopic pregnancy. In the experience of Titus a period of sterility may follow an earlier pregnancy.

In thirty-six (20.8 per cent) of the patients in this series there was a period of relative sterility ranging from three to seventeen years.

In Weil's series 32 per cent had relative sterility of five years or longer. Sadler reports relative sterility ranging from six to seventeen years in 26.6 per cent of his cases. Lisa et al. state that 48.3 per cent of their multiparae had a period of sterility of three or more years;
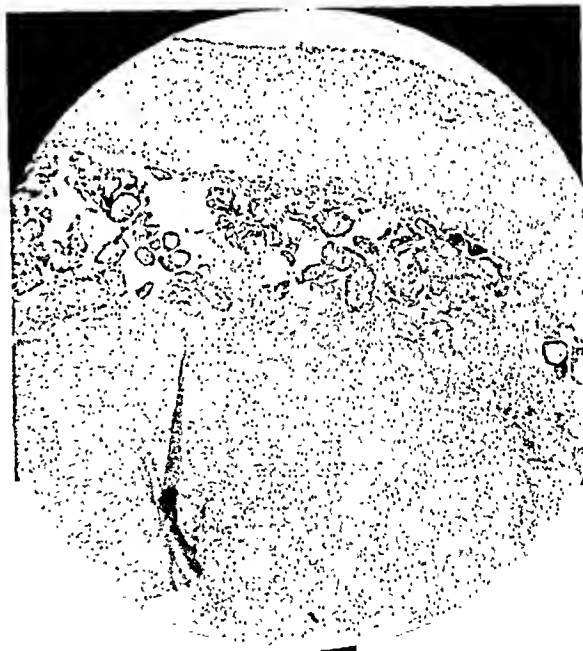
Fig. 8. Case ii, J. M. Same as Figure 7; higher magnification.

60 per cent of the multiparae in Brown's series experienced relative sterility of three or more years. Of the ten cases of secondary abdominal pregnancy reported by Reel and Lewis, nine patients were sterile from three to twelve years; the other patient was a nullipara.

On the other hand, Fitzgerald and Brewer found that "a long period of sterility is not the rule."

In evaluating relative sterility as an etiologic factor one should keep in mind the fact that
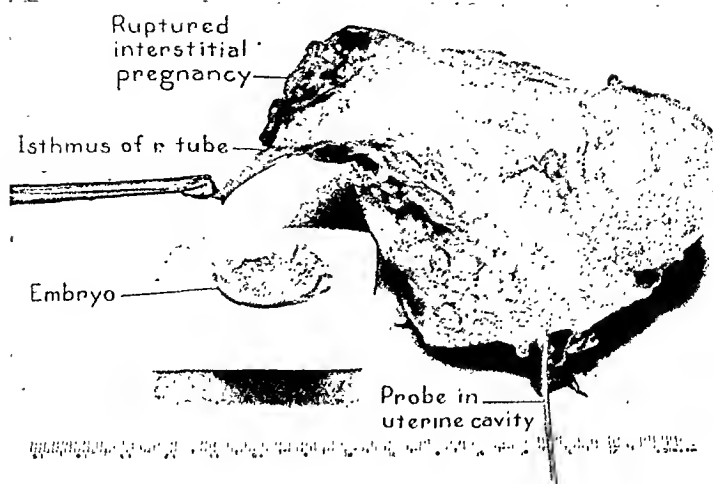
FIG. 9. Case III, E. C. Photograph of ruptured *interstitial* pregnancy
of right fallopian tube. Supravaginally extirpated fibromyomatous
uterus. Note clamp on proximal portion of the isthmus of right
fallopian tube. Insert shows the embryo; menstrual age of fetus
seventy-four days.

the physician seldom has absolutely reliable
information about the use of contraceptives
by all his patients and that temporary sterility
frequently occurs in the male.

Herzog says that inflammatory diseases of
the uterus and tubes should be disregarded as
possible causative factors in ectopic gestation.
He maintains that these conditions render a
woman temporarily sterile for either normal or
ectopic pregnancy.

Mall studied the fate of the ovum in 117
cases of tubal gestation. On the basis of this
work he concluded that in the presence of
acute or subacute tubal inflammation the
ovum degenerates. When the tube is convales-
cing from high infection, it possesses certain
anatomic characteristics, like saccules or mul-
tiple small lumina, which prevent the ovum
from completing its transit to the uterus. In
this convalescent state, however, the tube is
sufficiently healthy to permit tubal implanta-
tion and this occurs. If the pregnancy had not
occurred at this time, the tube probably would
have continued to heal and in a few years
would have been able to propel the ovum
safely to the uterus.

The greater frequency of ectopic gestation
in urban than in rural areas is further evidence
that pelvic inflammatory disease is a cause of
ectopic pregnancy. The higher incidence of
gonorrhea in cities explains this. Mall and
Stander remark specifically on the wider pre-
valence of gonorrhea in cities as a causative

factor. My own experience confirms this view.
The use of penicillin and sulfonamides should
reduce the importance of gonorrheal sal-
pingitis as a cause of ectopic gestation.

Salpingitis. The role of all varieties of
salpingitis in ectopic gestation is the same—
interference with the downward passage of
the ovum. This interference is caused by many
sequelae of the infection: saccules in which the
ovum becomes entrapped; adhesions which
cause tubal kinks; luminal stenosis or the
development of several narrow lumina which
preclude the free passage of the ovum. Sal-
pingitis also destroys the cilia necessary for
propelling the ovum and reduces the peristaltic
action of the tube. Tuberculous salpingitis
may seal the tube and exclude the ovum
entirely.

Adhesions. These may be caused by con-
ditions arising inside or outside the tubes.
Prominent causes are acute and chronic
appendicitis, pelvic and abdominal operations,
peritonitis occurring after rupture of an
intestinal or gastric ulcer, tuberculous peri-
tonitis, gonorrhea, puerperal infection, septic
abortion and perisalpingitis. In the experience
of Kelly peritoneal adhesions are a frequent
etiologic factor in tubal gestation because of
their serious constriction and relative occlusion
of the tubal lumen.

Abdominal and Pelvic Operations. These
surgical procedures are followed by inflamma-
tion and adhesions which may interfere with
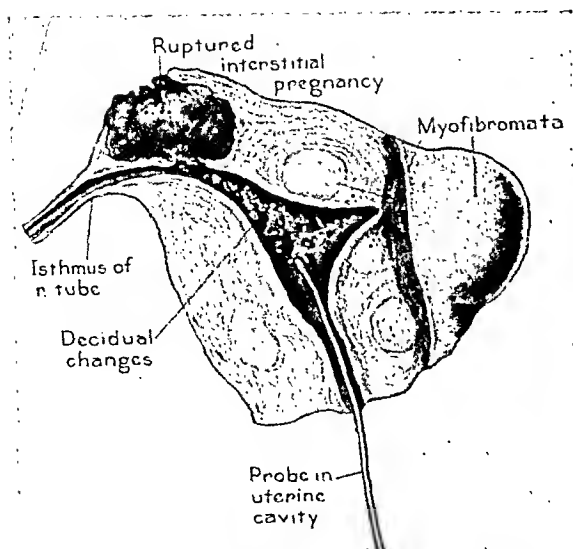
FIG. 10. Case III, E. C. Schematic drawing of section through extirpated uterus of Figure 9, showing rupture through the interstitial portion of right fallopian tube, distorted uterine cavity, hypertrophied endometrium and several fibroid nodules in myometrium.

FIG. 11. Case III, E. C. Photomicrograph through ruptured *interstitial* portion of right fallopian tube. Note chorionic villi burrowing into crater-like depression in the musculature; low magnification.

tubal peristalsis or result in tubal stenosis. In the present series thirty-four (19.7 per cent) of the 173 cases had had previous abdominal and pelvic operations as follows: appendectomy, cholecystectomy, myomectomy, suspension of uterus, cesarean section, previous ectopic pregnancy, partial salpingectomy and cauterization and conization of cervix.

Attempts to interrupt pregnancy by abortion may bring about tubal implantation. In fifty-five (31.8 per cent) of the patients in our series there was a definite history of previous abortion. Anspach points out that ectopic gestation increased greatly after the legalization of abortion in Russia. Schauffler and Wynia report that 34 per cent of the patients in their series had had abortions. Langman and Goldblatt's series of 310 cases reveal an unusually high incidence of previous lower abdominal operations.

Neoplasms. The growths may be within the tube or near it. Internal growths include tumors originating in the tubal mucosa or folds, polyps or pedunculated tumors such as chondroma (Outerbridge). External growths include parovarian cyst (Cullen and Brady), ovarian cysts, fibroids, adenomyoma of the uterine cornu and myomi uteri. Internal growths near the interstitial portion of the tube act as a mechanical barrier to the passage of the ovum. External growths which press upon the tube constrict its lumen. Even a

bean-sized fibroid at the cornu (Figs. 9, 10, 11, 12 and 13, Case III) may narrow the lumen of the tube.

Congenital Malformations. These are probably the result of an anomaly in the embryonic development of the Müllerian ducts. In 1946 I discussed sequelae of maldevelopment of these ducts. Congenital malformations include trumpet-shaped tubes, accessory ostia, accessory tubes, unusually long and narrow tubes, diverticula, tortuosity of the tubes, and infantile tubal convolutions. Accessory ostia, accessory tubes and diverticula terminate as saccules in which the ovum becomes entrapped but they do not interfere with the peristaltic action of the tube. Tortuosity, convolutions, unusual length and narrowness of the tube interfere with the progress of the ovum. Infantile tubes show imperfect ciliary development.

Abnormal Ovum. The abnormality may take the form of an excessively large twin ovum which, because of its size, cannot complete the tubal passage even before development of its trophoblast.

Tubal Atrophy. This state may be caused by malnutrition or hormonal disturbance and
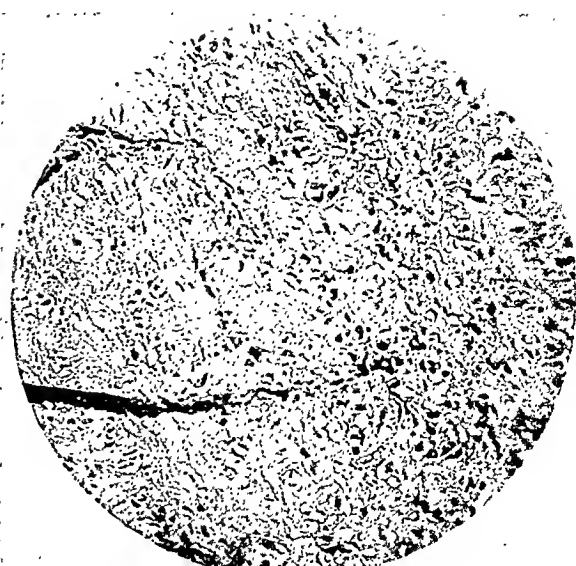
Fig. 12. Case III, E. C. Same as Figure 11; high magnification.
Fig. 13. Case III, E. C. Ruptured interstitial pregnancy. Photomicrograph of a section from the cornu shows decidual reaction; high magnification.

may follow puerperal infection. It results in reduced peristalsis.

External Migration of the Ovum. Because of an atretic or occluded tube, the ovum may travel to the opposite side. Ectopic nidation is then produced because the egg has grown abnormally large and because its trophoblast has developed.

Endometriosis, Decidual Response. The importance of decidual response as an etiologic factor in tubal pregnancy remains uncertain. Together with endometriomatous patches, it has been conceded by some authors (Curtis, Kerr) to be a possible cause of ectopic gestation. At laparotomy nests of endometriosis are often encountered. On the other hand, in 310 cases Langman and Goldblatt found no substantial evidence to confirm endometriosis as an etiologic factor.

Tubal Spasm. By constricting the tubal lumen, the spasm retards the downward passage of the ovum. The spasm may be the result of nervous influences or the use of certain drugs.

Metabolic Deficiency. It is Allen's belief that the most frequent cause of ectopic nidation is a marked metabolic defect, probably of nutritional origin, which might affect not only the germ plasm itself but also the pelvic transportation system by changes in pelvic physiology.

Intra-uterine Pessary. According to Welton and Ellingson this contraceptive device is likely to give rise to chronic endometritis and to facilitate the establishment of infection which may result in salpingitis. Both conditions may cause ectopic pregnancy. In three years Potter encountered three cases of ruptured ectopic gestation in which the patient was wearing a pessary at the time of examination.

Abdominal Pregnancy. Most cases of abdominal pregnancy are secondary, the result of a rupture into the peritoneal cavity from the original site of nidation. However, there are cases of abdominal pregnancy on record which were undoubtedly primary.

In 1888 Lawson Tait said, "That a fertilised ovum may drop into the cavity of the peritoneum and become developed there, is a contingency I cannot accept for a moment, for the powers of digestion of the peritoneum are so extraordinary that an ovum, even if fertilised, could have no chance of development."

Curtis states that primary abdominal pregnancy may not be as rare as it was formerly thought to be. He surmised that the increased incidence of pelvic endometriosis has brought with it a corresponding increase in the incidence of primary pregnancy in the abdominal cavity.

Anspach says, "The frequency of endometriomatous patches on the peritoneal surface and the occurrence of decidual reactions (20 per cent of all pregnant women who came to

FIG. 15. Case IV, V. S. Schematic drawing of abdominal pregnancy. Uterus and cervix pushed to the right by the fetus in the sac. The sac fills most of the pelvic cavity and almost reaches the umbilicus. It covers the left side of the uterus anteriorly and posteriorly. The sac is formed by the left fallopian tube and ovary and left lateral wall of pelvis.

on first examination no masses may be felt, there may be tenderness and rigidity of the fornices; at a subsequent examination a pelvic mass may be discernible.

The complaint may be so mild that the patient does not consult her physician. Even the more pronounced signs of incipient rupture or abortion do not alarm some women and if such a patient does consult her physician, he may dismiss her for lack of significant symptoms. In time circulatory changes may separate the ovum from its blood supply and fetal death takes place with absorption of the embryo.

Women are notoriously indifferent to deviations from normal menstruation. It is safest for the physician to assume that any irregular hemorrhagic vaginal discharge is indicative of a disturbed pregnancy or of malignancy as these conditions may require immediate and strict supervision. He should make a prompt attempt to ascertain the true cause of the bleeding.

Tenney calls attention to the absence of spotting as a danger signal. He says, " . . . it stands out definitely that the acute type of cases and the more dangerous were those that did not show staining on admission."

In our hospital service we frequently encounter desperately ill patients brought in by ambulance from whom it is often impossible to obtain any information of diagnostic value. If they are able to give information, they often insist that they were perfectly well up

to the onset of the acute symptoms. These patients are among the severe cases in whom we usually find massive hemorrhage (Figs. 9, 10, 11, 12 and 13.)

Tenney adds, "The absence of bleeding indicates a living pregnancy up to the time of rupture and therefore a more potentially dangerous source of disaster."

The other variety of atypical case follows one of three courses: (1) It presents the features of an incipient abortion or small rupture which disturbs or kills the ovum, resulting in a slow leakage of blood into the peritoneum. (2) The ovum may survive disturbance and be aborted into the peritoneal cavity where it may continue to develop as a secondary abdominal gestation and follow the characteristic course of that condition. (Figs. 15 and 16, Case IV.) (3) Blood may accumulate in the tube and form a hematosalpinx. (Figs. 17 and 18, Case V.) The tube may rupture at the infundibulum, the blood escaping into the peritoneal cavity and forming a hematocele. If tubal rupture occurs between the layers of the broad ligament, a hematoma results.

This atypical patient presents well defined symptoms of her condition. Careful evaluation of the history is important. It usually will include dull, unilateral, colicky pain and perhaps amenorrhea. Coincident with or close to the onset of pain brownish vaginal bleeding or spotting appears. Decidual shreds may have been passed.

Physical examination reveals abdominal

tenderness over the site of pain. A unilateral pelvic mass is often present and a hematocele may be palpable. The cervix is soft and tender; the uterus is slightly enlarged. The pulse, temperature and leukocyte count are usually somewhat elevated.

This patient is not in immediate peril. The surgeon may make an immediate diagnosis of ectopic gestation but he should not be considered remiss if he insists on employing diagnostic aids to help him differentiate the ectopic gestation from several other pathologic entities which closely simulate it.

The symptoms which may lead to a diagnosis of ectopic gestation can be so confusing that the physician may well consider the possibility of this condition in any woman of child-bearing age who complains of unilateral lower abdominal pain and menstrual irregularity of recent origin. The clinical picture may be clouded by the appearance, order and severity of the symptoms and by concomitant pathologic findings.

The signs most often encountered are amenorrhea, abdominal pain, vaginal staining or bleeding, abdominal and pelvic tenderness and masses.

Amenorrhea. This symptom is not nearly as uniform as abdominal pain. In the present series 126 patients (73 per cent) of the 173 cases studied had amenorrhea and forty-seven (27 per cent) did not.

Atlee reports that approximately one-half of his patients with ectopic pregnancy presented this symptom. Kerr found that in many of his patients one period was usually missed before the onset of pain and hemorrhage. Burch and Seitchik report that 90 per cent of the patients they studied had missed a period. Ware and Winn (1941) found that 50.66 per cent of their patients experienced no amenorrhea; 28 per cent had missed one menstrual period; 16.66 per cent had missed two menstrual periods and 2 per cent had missed more than two periods. Torpin (1945) reports that 75 per cent of his patients complained of amenorrhea.

Patients sometimes experience amenorrhea but fail to report it because they confuse vaginal spotting or bleeding with a menstrual period. It requires meticulous questioning by the examiner to elicit the facts and the patient's condition may not permit this. Disturbance or death of the ovum with subsequent uterine hemorrhage frequently takes place before or

Fig. 16. Case iv, V. S. Abdominal pregnancy; roentgenogram of fetus after removal from sac. This fetus was a male, 9 cm. in length. It moved feebly for a few minutes after birth; fingernails were present. Roentgenogram reveals centers of ossification in diaphyses of all long bones of hands and feet.

near the next period so that the patient regards the vaginal discharge as a regular menstruation.

Pain. This is the commonest symptom reported. In our series abdominal pain was present in 153 patients (88.4 per cent). In thirty-seven patients it occurred mainly in the right lower quadrant; in thirty-six in the left lower quadrant and in eighty patients it was generalized.

In a study of 410 ectopic gestations Lavell found pain in every patient from whom a complete or reliable history was obtained. Fitzgerald and Brewer report that some type of pain was the most common symptom in their 500 cases. Two-thirds of their patients complained of sudden, severe pain. Marchetti et al. found pain in 98.5 per cent of their patients. In Atlee's study some degree of pain
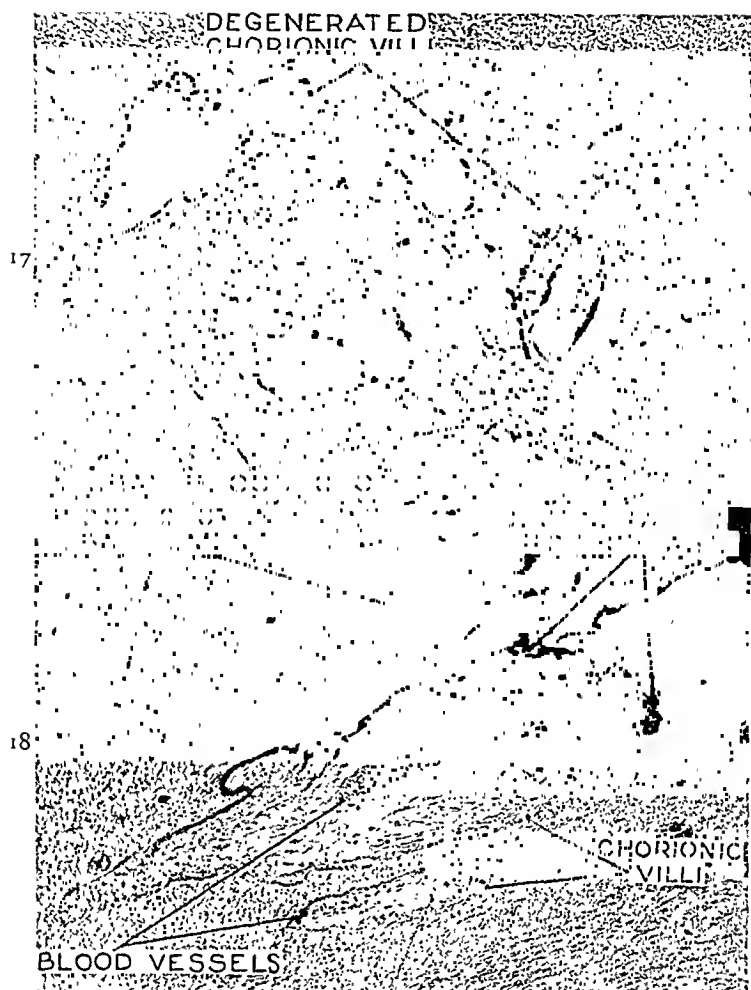
Fig. 17. Case v, O. G. Preoperative diagnosis was left ovarian cyst. Postoperative diagnosis was hematocele. After making many microscopic sections in the wall of the tube, no chorionic villi were found. After making many sections through the blood clot, several necrotic chorionic villi were found in the midst of the blood clot.

Fig. 18. Case v, O. G. Preoperative diagnosis was left ovarian cyst; postoperative diagnosis was hematocele. After making many microscopic sections in the wall of the tube, no chorionic villi were found. Two vascularized chorionic villi were found in the midst of the blood clot. The villi and the remnants of the living trophoblastic cells are completely necrotic.

was reported by every patient. Kerr states that pain is almost universally present.

The onset of pain generally occurs after exertion, coitus or defecation. Its character varies according to the status of the pregnancy. The pain immediately preceding, accompanying and following ectopic rupture or abortion is severe, knife-like and lancinating. In some cases its onset is preceded by several days of indefinite cramps. It may be continuous or intermittent. At first it is usually unilateral, restricted to the site of the pregnancy. Later it may become generalized over the entire abdomen and spread to other parts of the body. Extension of pain to the shoulder is a common symptom. Other sites to which pain may be referred are the rectum, umbilicus, bladder, legs and gallbladder area.

The severe pain characteristic of ectopic gestation is caused by (1) distention of the tube and tearing of the tubal structures during rupture or abortion; (2) irritation caused by blood in the peritoneal cavity; (3) subdiaphragmatic accumulation of blood irritating the phrenic nerve, thus resulting in acute shoulder pain.

According to Falls (1941) the pain of unruptured ectopic gestation is rarely severe; it is usually unilateral and colicky. This pain is the result of (1) erosion by the chorionic villi and (2) tubal distention. While it is usually sufficiently severe to cause the patient to seek medical aid, it may be limited to minor discomfort.

Vaginal Staining or Bleeding. This is a frequent symptom. In my series vaginal bleeding or spotting was a symptom in 126 cases (73 per cent). Farell and Scheffey report that the majority of their cases of ruptured tubal pregnancy were characterized by bleeding before the expected time of menstruation. The majority of Fitzgerald and Brewer's patients complained of "abnormal bleeding." In their series of 115 cases Lisa et al. found that ninety-seven had experienced some bleeding. Ware and Winn (1946) say that in three out of every four cases of ectopic gestation some kind of hemorrhagic vaginal discharge is present.

As long as the ovum remains intact and continues to develop, uterine bleeding is usually absent (Schumann). The hemorrhagic vaginal discharge is caused by shedding of the degenerated uterine decidua after disturbance or destruction of the ovum. At times the entire decidua is expelled as a cast and both the physician and patient mistake it for an early aborted intra-uterine pregnancy. Unless a thorough microscopic examination is done and trophoblasts are found, it is impossible to make a proper diagnosis.

Vaginal bleeding may be limited to dark brown, scanty spotting, intermittent or continuous; or it may be sufficiently profuse to suggest intra-uterine abortion, especially if accompanied by decidual shreds. Profuse vaginal bleeding is more apt to be caused by intra-uterine than by extra-uterine gestation. The vaginal bleeding is never proportionate to the internal loss of blood. Because the onset of the staining or bleeding is sometimes coincident with an expected menstruation, the patient may incorrectly believe that a regular menstruation is in progress.

Vaginal bleeding may be the first symptom noted. It may be coincidental with the onset of pelvic pain or it may follow pain. Farell and Scheffey found that the majority of patients with tubal rupture reported vaginal bleeding before the expected menstrual period.

At vaginal examination the physician may detect hemorrhagic discharge of which the patient was unaware.

Nausea and Vomiting. Although these symptoms are common characteristics of advanced abdominal pregnancy, they do not appear with marked frequency in the types of ectopic gestation which terminate early. When they appear as early symptoms, they are the result of peritoneal irritation, intramural hemorrhages which cause distention of the tubal wall and tubal colic.

In this series nausea and vomiting occurred in fifty-six cases (32 per cent). In Meagher's 247 cases of ruptured ectopic gestation, 147 patients complained of "vomiting of rupture." Langman and Goldblatt found that nausea was the most frequent general symptom with 162 patients reporting it; in the same series 140 patients complained of vomiting. Nucci reports that twenty-two of his 150 cases complained of nausea and vomiting. Lisa et al. noted vomiting in thirty and nausea in nineteen of their 115 patients.

Faintness and Weakness. These appear with varying degrees of frequency and are the result of rupture or abortion. They are likely to appear more often when the initial bleeding is massive or in the patient who ignores the early signs of her condition and in whom bleeding becomes extensive.

In my series of 173 cases faintness and weakness occurred in 81 patients (47 per cent). This included sixteen who were in shock. In the series reported by Marchetti et al. 29.1 per cent experienced these symptoms. In Langman and Goldblatt's series of 310 cases, 133 patients complained of weakness and ninety-one fainted. Actual syncope occurred in 64.8 per cent and faintness in 18.8 per cent of Falk and Rosenbloom's patients.

According to Moon shock is caused by "*a disparity between the volume of blood and the volume-capacity of the vascular system.*" Although this symptom is not reported with uniformity, hemorrhagic shock is present in some degree in all cases of tubal rupture or abortion (Woodhouse). The reduction in the volume of blood is manifested by falling blood pressure and temperature, a rapid, feeble pulse, rapid respiration, pallor with clammy skin, faintness and syncope.

Shock was present in sixteen (9.2 per cent) of the patients reported in this series. Various

authors report the percentage of patients admitted in shock as follows: Marchetti et al., about 10 per cent; Leff and Winson, 26.1 per cent; Sadler, 27.4 per cent. Fitzgerald and Brewer report severe collapse in 18.2 per cent of their cases. In the series reported by Mac-Farlane and Sparling forty-one patients (37.3 per cent) experienced preoperative shock.

DeLee and Greenhill (1943) consider tubal distention to be a cause of shock. They state that severe prostration without enough blood loss to explain it has been observed. Trauma is undoubtedly the cause of such preoperative collapse.

Urinary Disturbances. These results of peritoneal irritation set up by hemorrhage into the cul-de-sac are sometimes reported. Bladder irritation with frequent micturition may appear as an early symptom. Dysuria may appear in a mild degree after intraperitoneal hemorrhage.

In this series there were definite urinary symptoms in eleven cases (6.35 per cent). Undoubtedly this condition was present in a greater number of patients but for various reasons the facts were difficult to determine.

Of Meagher's 247 cases of ruptured ectopic gestation, seventy-six suffered from urinary symptoms. Anuria is occasionally encountered.

Infrequent Symptoms. Several symptoms are observed with minor frequency. In unruptured tubal, ovarian or abdominal pregnancy the classical signs of normal gestation may be constant indicators of the condition, but in the other types of ectopic gestation they are not sufficiently dependable to be of appreciable diagnostic value (Siegler). Breast changes, for example, are reported infrequently in ectopic gestations that terminate at an early date but they may well be expected in long-term abdominal pregnancy. In his series of 474 cases Urdan observed colostrum in the breasts of only twelve patients. Intraperitoneal hemorrhage, by its irritative effects, may cause constipation alone or constipation alternating with diarrhea. Reel and Lewis believe that in abdominal pregnancy the significant symptom of lower abdominal pain associated with growing constipation is the result of the intra-abdominal locus of the placenta and the inclination of this organ to adhere to the sigmoid. Rectal tenesmus, caused by feces pressing upon the blood deposited in the cul-de-sac, is sometimes reported. It was a complaint presented by eight of my patients.

The patient may show signs of early pregnancy, such as Chadwick's (Jacquemier's) sign.

Abdominal and pelvic examination may be unnecessary because of the presence of objective symptoms confirmatory of a preoperative diagnosis of ectopic gestation. Such examinations may be impossible because the serious condition of the patient precludes them and makes immediate surgical intervention imperative. In carrying out the physical examinations, the physician should exercise the utmost care lest he cause rupture of an intact pregnancy or further hemorrhage of an already ruptured sac.

Abdominal examination reveals varying degrees of tenderness which usually is most noticeable in the area of severest pain.

In my series tenderness and rigidity were observed in eighty-three cases (48 per cent). In twenty-five patients (14 per cent) these signs were noted mainly in the right lower quadrant; in fifteen (9 per cent) in the left lower quadrant; in forty-three (25 per cent) they were generalized; and in seven (4 per cent) they were not observed.

Lisa et al. found that tenderness was the most frequent sign; it was detected in eighty-eight of their 115 patients. Atlee found some degree of abdominal tenderness in all his patients.

The tenderness may be generalized but more often it is confined to one or both lower quadrants. In some cases the abdominal tenderness is out of proportion to the pelvic findings. Rebound pain and abdominal distention are sometimes observed. Resistance often extends over the entire abdomen and is apt to be maximal at the site of greatest tenderness. The rectus muscles may be rigid.

Abdominal Masses. These were observed in thirteen patients (7.5 per cent) in this series. In seven patients they were detected in the right lower quadrant, in four in the left lower quadrant and in two instances they were found in the hypogastrium. Many of the remaining patients in the series may have had abdominal masses but because of rigidity and severe pain, it was impossible to discover them.

Cullen's sign, a bluish discoloration at the umbilicus, is a valuable indication of intraperitoneal hemorrhage. This sign, however, is rare. It is discernible most often in patients with umbilical hernia.

Abdominal examination may suggest any of

several pelvic pathologic conditions, namely, ectopic gestation, appendicitis, acute salpingitis, pelvic exudate, intestinal obstruction or ovarian cyst.

An infrequent but important abdominal finding is fluid wave which is present in cases of intraperitoneal hemorrhage. (See Case III.) This symptom was elicited in only four of my cases. Patients who may show a fluid wave are usually so desperately ill that they cannot be subjected to manipulation to elicit this sign. Torpin (1944), who noted it in nineteen women, emphasizes its value in the presence of "an abdominal crisis." Meagher reports this symptom in forty of his 247 cases of ruptured ectopic gestation.

Pelvic examination reveals a variety of signs which are the result of the age of the pregnancy and the extent of internal hemorrhage. There is general agreement among physicians on the excessive tenderness encountered when pressure is exerted on the affected side. Unilateral pelvic mass and cervical tenderness are the most significant findings. Careful recto-vaginal examination should be made to establish the connection of the extra-uterine mass with the uterus.

In the first weeks the cervix and uterus show no changes. As the pregnancy grows, however, the cervix softens and assumes a bluish hue. Often the cervix is so tender that manipulation of it causes severe pain and prevents extensive pelvic examination.

Tenderness on motion of the cervix was pronounced in fifty-one (29.5 per cent) of the patients in my series. Extreme cervical sensitivity is the result of changes caused by pregnancy and peritoneal irritation caused by blood in the cul-de-sac which affects the uterosacral ligaments, producing tenderness on motion (Johnson). The uterus softens and may enlarge. Typical uterine contractions or, rarely, contractions of the pelvic mass itself may be observed (Kelly). Formation of a hematocele results in uterine displacement. In the presence of free blood the cul-de-sac appears to be distended. If the blood has clotted, a definite mass can be palpated.

In thirty-six of the patients studied in this series the uterus was distinctly palpable; in twenty-three patients it was enlarged; in four retroflexed; in five soft; in three tender; and in one patient malformed. In other cases the uterus could not be mapped out because of pain or the extreme obesity of the patient.

Johnson frequently observed unilateral pulsation of the uterine artery.

Burch suggests that in making the pelvic examination the index finger should be inserted into the vagina, the ring finger into the rectum and palpation from the abdominal side should be made between the vaginal and rectal fingers.

Pelvic Mass. This will be palpated if the pregnancy is large enough or if clots have been formed by free blood. While a palpable pelvic mass is often reported, its absence should not rule out ectopic gestation. The pelvic mass may be in the adnexal region, in the cul-de-sac or in both places.

Pelvic masses were palpable in eighty-nine patients (51.4 per cent) in my series. In thirty-four patients the mass was detected in the right fornix, in twenty-eight in the left fornix and in twenty-seven in the posterior cul-de-sac. Tenderness of lateral fornices and posterior cul-de-sac was often elicited even though no masses were found. In some of these cases where operation was postponed for clarification of diagnosis masses were discovered on subsequent examination.

Lisa et al. found an adnexal mass in sixty-four of their 115 patients, a mass in the cul-de-sac in thirteen and a combined cul-de-sac and adnexal mass in eleven. Torpin (1945) considers pelvic mass a cardinal sign of ectopic gestation; he was able to detect pelvic masses in 94 per cent of his cases. Leff and Winson noted a palpable mass in 116 (62.6 per cent) of their patients. In cases where no mass can be palpated these authors call attention to the importance of marked tenderness elicited when the broad ligament on the affected side is put on tension.

Schauffler and Wynia found a lower abdominal mass in 44 per cent of their cases. Marchetti et al. palpated a pelvic mass in 70.2 per cent of their patients. Pelvic examination was not considered necessary in fourteen cases and in 19.1 per cent of their series no mass was found.

The pelvic mass varies in size, consistency and position. The age of the pregnancy and the extent of intramural hemorrhage determine its size. As time goes on the tube becomes adherent to the ovary, broad ligament or intestines; this results in the formation of a mass which usually is very sensitive. The mass may be soft and elastic; if there has been mural

hemorrhage in the tube, the swelling will be firm. The pregnant tube in its early weeks usually presents a unilateral swelling behind the uterus. As it grows it extends backward and downward, pushing the uterus forward and upward. The mass is rarely located in front of the uterus (Kerr). Before rupture the mass is egg-shaped or cylindrical; after rupture it assumes an irregular contour. A fluid or coagulated mass of blood in the cul-de-sac is evidence of repeated minor hemorrhages. Massive hemorrhage usually requires surgical intervention before blood clots can form. The pelvic masses palpated by Schauffler and Wynia varied from 5 to approximately 15 cm. in diameter.

Decidual Cast. This is of great diagnostic value but it should not be awaited as a confirmatory symptom in ectopic gestation because, first, it is a relatively late sign following severe pain with tubal abortion or rupture and, second, because it is not very often seen. Its passage may be unnoticed by the patient. Accompanied by hemorrhagic discharge of uterine origin, it indicates disturbance or death of the ovum. Of the 173 cases studied in my series, sixteen passed decidual casts which showed decidual reaction microscopically but no chorionic villi. One patient passed a cast that showed neither decidual reaction nor chorionic villi. Kerr and Mahfouz noted this symptom in 25 per cent of their patients.

Temperature. Writers are not entirely in agreement on the temperature in ectopic gestation but in general it may be said that in typical cases it is usually normal or subnormal and in atypical cases, normal or above normal. A subnormal temperature is one of the signs of massive intraperitoneal hemorrhage. The increased temperature reflects peritoneal irritation by free blood and the existence of mild pelvic peritonitis.

In our series of cases the temperatures were not high unless pelvic infection was present. They were subnormal in patients with abdominal hemorrhage. The highest temperature was 101.6°F. and the lowest was 95°F. Other readings were as follows: In sixty-two patients (36 per cent) temperatures were 100°F. or above; in ninety patients (52 per cent) temperatures were 98.6°F. to 100°F.; in twenty-one patients (12 per cent) temperatures were below 98.6°F.

In the experience of Fitzgerald and Brewer 84.8 per cent of patients with ectopic pregnancy had temperatures of 100°F. or below. Ware and Winn (1941) report that the temperature usually shows slight elevation. Atlee believes that "a subnormal temperature is a useful confirmatory sign in a woman with severe low abdominal pain and signs of internal haemorrhage, since acute ectopic is the only critical low abdominal condition likely to be associated with a subnormal temperature."

Pulse Rate. A pulse, increasing in rate and decreasing in volume, usually accompanied by a low hemoglobin index, may be expected in the presence of intraperitoneal hemorrhage. In my series of cases the highest pulse rate was 140; the lowest was 68. In an analysis of the cases the following rates were observed: In seventy-nine patients (46 per cent) the rate ranged from 68 to 90; in thirty-seven patients (21 per cent) the rate ranged from 91 to 100; in fifty-five patients (32 per cent) the rate ranged from 101 to 140; in two patients (1 per cent) the rate was imperceptible.

Ware and Winn (1946) consider a rapid pulse one of the most characteristic symptoms of ruptured ectopic gestation. These authors regard the rate and volume of pulse as more reliable indices of the condition of the patient who has recovered from the initial shock than the blood pressure readings. One hundred eleven (74 per cent) of Nucci's patients had pulse rates below 100. The remaining thirty-nine, cases of tubal rupture or tubal abortion, had pulse rates between 100 and 130 beats per minute. In cases of massive hemorrhage a rapid or thready pulse is frequently observed as part of the clinical picture and it generally is admitted that a persistent or increasingly rapid pulse rate is an important finding.

Blood Pressure. As one might expect, blood pressure drops when tubal rupture or abortion occurs. The decreasing blood pressure favors hemostasis (Titus). Should the blood pressure rise, hemorrhage is apt to be renewed (Welton, 1924).

Blood pressure readings were available in 147 cases (85 per cent) in this series. They are shown in Table IV.

Blood pressure was not recorded in twenty-six (15 per cent) of our patients. It will be noted that the high systolic pressure of 220 mm. had a corresponding diastolic pressure of 135 mm.; the systolic pressure of 170 mm. had a corresponding diastolic reading of

120 mm. In the systolic pressure of 40 mm. no diastolic pressure could be obtained. This patient, however, recovered. Low blood pressure readings were marked in cases of massive intra-abdominal bleeding.

Nucci found systolic readings below 100 mm. in one-third of his cases of tubal rupture while

TABLE IV

Systolic	No. of Cases	Diastolic	No. of Cases
60– 70 mm.	9	20–50 mm.	22
71– 90 mm.	20	51–70 mm.	71
91–120 mm.	83	71–90 mm.	51
121–138 mm.	32		
220 mm.	1	135 mm.	1
170 mm.	1	120 mm.	1
40 mm.	1	0 mm.	1

among twenty-five unruptured tubal pregnancies only three had systolic readings below 100 mm. In Schumann's experience the systolic blood pressure in cases of tubal rupture or abortion vacillates between 90 and 110 mm. with a constant pulse tension. Ware and Winn (1946) report, "The blood pressure is usually normal in the patients with a pelvic mass and below 100 systolic most frequently in the acutely ruptured cases."

Leukocyte Count. Ectopic rupture or abortion produces leukocytosis which may be very high. It is the result of peritoneal irritation caused by the free blood. The leukocyte count drops precipitously when the hemorrhage stops but rises if it is resumed.

In our series of 173 cases the leukocyte count was reviewed in 157 patients (91 per cent) and is shown in Table v.

TABLE V

	No. of Cases	Per Cent
5,000–10,000	79	50
10,001–15,000	48	31
15,001–20,000	20	13
20,001–25,000	7	4
25,001–30,000	3	2

In the seventy-nine patients in whom the leukocyte count ranged from 5,000 to 10,000 laparotomy revealed an unruptured ectopic or slow leakage from a tubal pregnancy or old

blood clots in the abdominal cavity indicating an old rupture. When symptoms indicated that rupture was recent and not massive, the leukocyte count was about 15,000. When the bleeding was recent or massive, the leukocyte count ranged from 15,000 to 30,000.

The count varies with the extent of intraperitoneal hemorrhage and the rate of blood absorption. As the hemorrhage ceases and the intraperitoneal blood is absorbed or sealed off, the leukocyte count decreases rapidly. In 85 per cent of Atlee's cases the leukocyte count was above 10,000, the figure considered to be an upper normal limit (Farrar).

The red blood cell count, like other laboratory data, should be evaluated in the light of the clinical picture as a whole. There is usually a significant degree of correlation between the red blood cell count and the hemoglobin index. In the presence of intraperitoneal hemorrhage, repeated analysis almost always reveals a falling red blood cell count and hemoglobin index. However, these blood studies do not necessarily indicate the amount of blood loss.

In this series a red blood cell count was recorded in 159 cases (92 per cent). The highest count was 6,500,000; the lowest 1,170,000. In an analysis of cases the following counts were observed:

Count	Cases	
	No.	Per Cent
One million and over..............	5	3.10
Two million and over..............	41	25.78
Three million and over............	81	51.00
Four million and over.............	31	19.49
Over six million..................	1	.63

Hemoglobin index signifies the withdrawal of blood from the general circulation. Ware and Winn (1941) state that rapid decreases in the hemoglobin index and red blood cell count and a concomitant increase in leukocytes point to internal hemorrhage. These authors believe that a rapid decrease in hemoglobin is a more valuable symptom than the initial reading. They frequently noted a decrease in hemoglobin and red blood cell count, associated with recurring pelvic pain and temporary leukocytosis. The hemoglobin index, like the red

blood cell count, does not reflect the true status of blood depletion until the passage of twenty-four to forty-eight hours.

Anemia depends upon the extent of blood loss. According to Kelly, anemia resulting from successive hemorrhages may be so severe as to cause death. An incomplete tubal abortion tends to bleed repeatedly (Titus). Torpin (1944) says that unsuspected anemia is very suggestive of ectopic gestation.

The sedimentation rate may be increased by massive hemorrhage even though infection is absent. The rate is seldom high unless infection sets in. However, if the rate is taken when hemorrhage starts and the hemorrhage is massive, the rate may be high. The pregnancy alone may increase the sedimentation rate.

Sedimentation values were noted in ninety-two cases (53 per cent) in this series. In thirty-two of these patients the values were normal. The rates were as follows:

Rates	Cases	
	No.	Per Cent
5–10 mm.	32	35
11–15 mm.	16	17
16–20 mm.	13	14
21–25 mm.	13	14
26–30 mm. and above	18	20

In the experience of Nucci the rates were most rapid in cases of tubal abortion and tubal rupture and especially in those patients in whom there were concomitant low hemoglobin readings and pelvic inflammatory disease. This author noted a high correlation between the increased sedimentation rate and the extent of the peritoneal hemorrhage.

SYMPTOMS AND PHYSICAL FINDINGS
ABDOMINAL PREGNANCY

Most abdominal gestations are secondary implantations usually resulting from tubal rupture or abortion. This condition presents many of the early symptoms of the other types of ectopic gestation. In the early weeks there may be amenorrhea, nausea, vomiting, signs of internal hemorrhage, weakness, fainting, syncope and a hemorrhagic vaginal discharge with or without passage of a decidual cast,

indicating rupture or abortion. The symptoms may be sufficiently grave to cause the patient to seek medical advice and to receive surgical relief. If she survives the early symptoms without medical assistance, the fetus may die and its remains be absorbed or they may form a pelvic hematocele.

Occasionally the fetus survives rupture or abortion and continues to develop in the abdominal cavity where its placenta attaches itself to whatever pelvic organs it contacts. With the passage of time, the characteristic symptoms of the abdominal environment manifest themselves. (See Case IV.) The patient continues to experience the usual signs of pronounced peritoneal irritation, namely, nausea, vomiting, constipation or diarrhea and difficult and frequent micturition. Nausea and vomiting may continue through the last months. Cornell and Lash (1934) say, "Vomiting of blood and the passage of blood per rectum are seen occasionally. This seems to occur when the placenta is attached to the intestines." Cornell believes these symptoms are caused by chorionic villi eroding into the intestinal wall.

After the fifth month the abdomen becomes very sensitive. Fetal movements cause great pain by irritating the visceral and parietal peritoneum. The pain is more severe if the placenta is attached to a vital organ than if it is attached to the uterus or its appendages (Cornell and Lash). The pain may be so intense that it confines the patient to bed much of the time of the pregnancy.

If the fetus dies, maceration takes place with low grade infection, fever and pronounced toxemia. The patient experiences weakness, increased constipation and malaise. Hemorrhagic vaginal discharge of uterine origin may appear. These symptoms subsequently disappear as the fetus undergoes calcification.

If term is reached, spurious labor sets in. This may be characterized by increased fetal movement; painful uterine contraction may ensue and vaginal bleeding with expulsion of blood clots and decidua may take place.

Physical examination reveals an empty although somewhat enlarged softened uterus alongside the fetal mass. For the first two months the uterus enlarges as in normal pregnancy. In advanced abdominal gestation it may reach the size of a four months' preg-

FIG. 19. Case VI, V. M. Abdominal pregnancy; the fetus is lying transversely; its skull is to the reader's right; vertebral column downward and ribs upward. The frontal region of skull is protuberant.

nancy; this occurred in some of my patients. The transverse position of the fetus (Figs. 19 to 22, Case VI), its unusually noticeable and painful movements and its abnormally loud heart tones are very pronounced. On bimanual rectovaginal examination the fetus and its movements can be palpated readily. In almost every one of Swanson's cases the fetus was found on the right side. Because of the absence of uterine musculature (Beacham and Beacham), the fetus appears to lie close to the surface of the skin. It can be moved readily and can be shifted from one abdominal quadrant to the other. The fetal parts can be palpated easily through the vagina. Braxton Hicks contractions are absent. The vagina is enlarged and soft. Although the cervix may be somewhat soft, it is usually firm and may be slightly dilated. Movement of it causes pain. Cervical displacement is governed chiefly by the position of the fetus. (Figs. 23 to 26, Case VII.) In his discussion of Schauffler and Wynia's paper on ectopic pregnancy, Casler called attention to an important observation made by Howard Kelly: "The cervix in abdominal pregnancy corresponds in size and consistency to the pregnancy above it, and not to the size of the uterus

itself." The cervix may be abnormally high or it may extend low into the vagina.

According to Kelly the placental souffle is occasionally audible. Unlike the condition which prevails in normal intra-uterine pregnancy, in ectopic gestation this sound is a valuable aid in locating the placenta (DeLee and Greenhill, 1943).

Hegar's sign and ballottement, characteristic in normal pregnancy, are absent.

Gardner and Middlebrook observed that abdominal pregnancy seldom is complicated by other diseases or tumors, including the toxemias of pregnancy.

One of my patients developed hypertension during the latter months of pregnancy. This woman also had a fibromyoma of the uterus. (Case IX.)

Harrar gave three points which are valuable in establishing a diagnosis of abdominal pregnancy:

"1. History in the early months of supposed miscarriage, with possible passing of shreds of tissue.

"2. Ability to feel the fetal parts suspiciously close beneath the abdominal wall . . .

"3. The most important is finding the uterine cavity short and empty."

Frontal
Protuberance
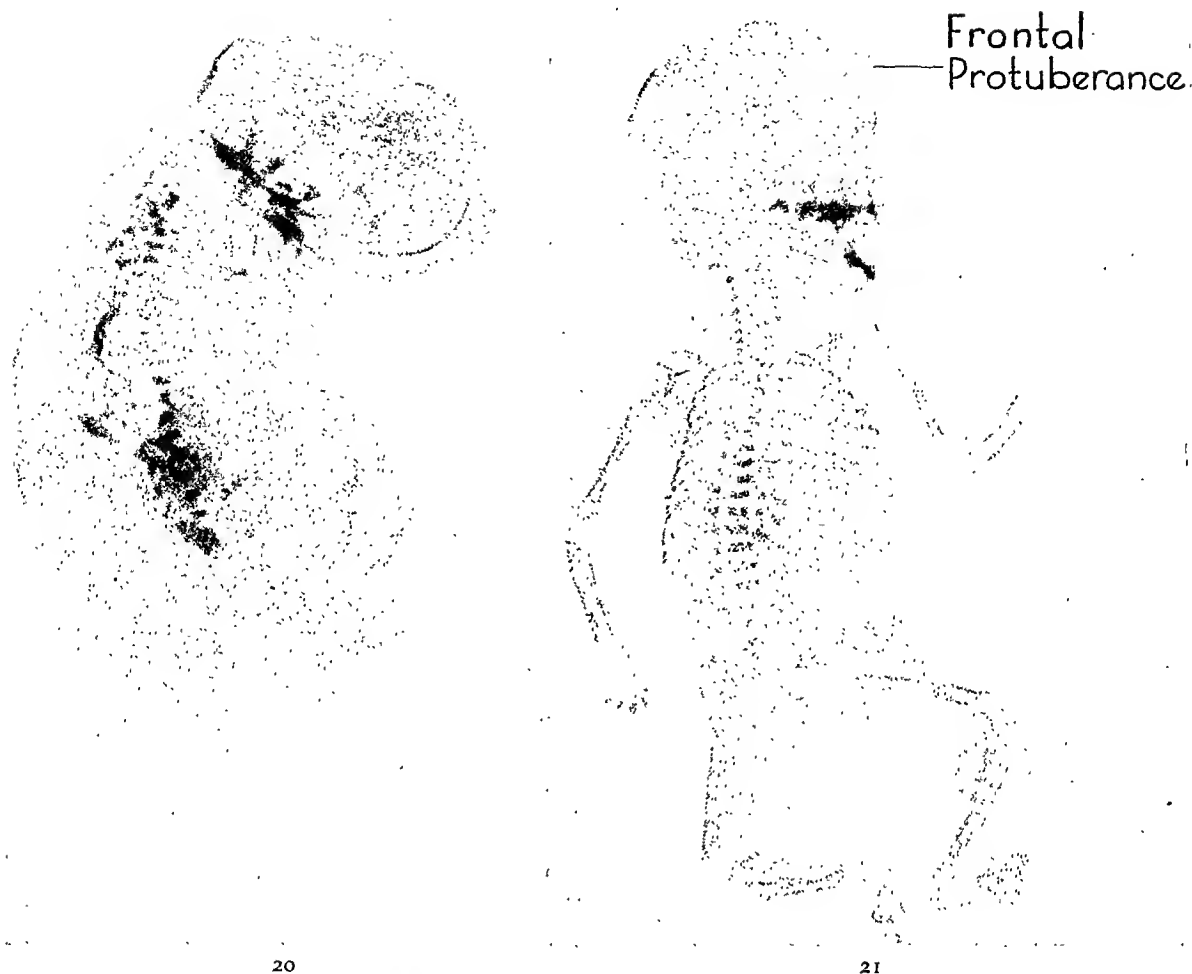
FIG. 20. Case VI, V. M. Abdominal pregnancy; roentgenogram of fetus in sac after removal from abdominal cavity; note frontal protuberance.

FIG. 21. Case VI, V. M. Abdominal pregnancy; roentgenogram of fetus after removal from sac; menstrual age nineteen weeks. Bony rudiments of milk teeth are seen. Ossification centers are discernible in the arches of the uppermost eleven vertebrae and in the phalanges of the fingers. These findings are consistent with a menstrual age of nineteen weeks. Ossification center of horizontal ramus of pubis is not seen; this does not usually appear before twenty weeks. The frontal protuberance is an anomaly.

A low voltage roentgenogram may reveal that the wall of the uterus does not envelop the fetus. Whenever it is possible to inject opaque media into the uterus and take a hysterogram, it will be observed that the uterine cavity does not contain the fetus. It is not always possible to administer the injection because the cervix may be very high and attempts to inject opaque media may fail. (Fig. 24, Case VII.)

OVARIAN PREGNANCY

The symptoms of ovarian pregnancy are the same as those of tubal gestation. According to Falls (1941), rupture with relatively severe hemorrhage occurs about the sixth or eighth week. On pelvic examination of very thin patients the ovarian sac can be felt as a cystic ovary rather than a dilated tube (Falls, 1941). The symptoms presented by this ectopic condition seldom enable the physician to make a preoperative diagnosis of ovarian pregnancy.

Norris believes that ovarian pregnancy is most easily diagnosed before it is six or eight weeks old because the gestation sac later grows so large that its relation to the surrounding parts is changed. Greenhill states that one cannot make a preoperative diagnosis of ovarian pregnancy; only a diagnosis of

ectopic gestation can be made. Operation establishes the clinical diagnosis. According to Wilson and Robins, ovarian pregnancy cannot be differentiated absolutely from tubal pregnancy before operation. The same authors call attention to the difficulty of distinguishing macroscopically between ovarian pregnancy and endometrial (chocolate) cyst. Schumann states that confirmation of a diagnosis of ovarian gestation can be made only by thorough microscopic examination.

In my series only tubo-ovarian cases were observed; no primary ovarian pregnancies were encountered. (Fig. 21, Case VI; Figs. 37 and 38, Case IX.)

CERVICAL PREGNANCY

Studdiford (1945) states that cervical pregnancy is a very rare condition and one that presents serious problems which sometimes terminate fatally. (Fig. 14.)

The most common sign of this unusual form of ectopic gestation is hemorrhagic vaginal discharge which often appears so early that amenorrhea may be absent. The bleeding has a tendency to increase in quantity as the pregnancy advances. Amenorrhea is sometimes reported. There may be nausea, indefinite lower abdominal pain, backache and urinary complications. In most instances it is the painless vaginal bleeding which compels the patient to seek medical aid. The usual symptoms resulting from hemorrhage are manifested in patients who have experienced massive bleeding. If the gestation is of more than three months' duration, abdominal examination will reveal a pelvic mass commensurate with the length of the condition. The uterus, firmer and smaller than the mass, will be adherent to it. Sometimes the uterus is thought to be a uterine fibroid.

Pelvic examination reveals uterine bleeding. The cervix is enlarged to correspond with the age of the gestation. If the age is more than twelve weeks, the external os will be partially dilated, permitting identification of the sac and occasionally the lower edge of the placenta (Studdiford, 1945).

DIAGNOSTIC AIDS

The experienced surgeon knows that the most valuable diagnostic aid in ectopic gestation is a good history. In my opinion there is no gynecologic condition in which a meticu-

lous history is of greater importance. Symptoms may differ in different individuals but the history usually follows a characteristic course. After the patient has reported the more common symptoms which point to an ectopic pregnancy (amenorrhea, pain or hemorrhagic vaginal discharge), the physician should question her regarding possible etiologic factors, e.g., salpingitis, previous pregnancies, relative sterility and pelvic and abdominal operations. In urgent cases, when there is no time for physical examination or diagnostic tests, the symptoms recited by the patient and her general physical appearance should be convincing evidence of the need for immediate surgical intervention.

The following are diagnostic procedures which should assist the physician in arriving at a correct preoperative diagnosis in non-urgent cases.

Aschheim-Zondek or Friedman Tests. These are positive in the presence of functioning chorionic villi. According to Titus, they continue to be positive from seven to ten days after the fetus has died. They do not differentiate between intra-uterine and extra-uterine pregnancy. In the absence of pregnancy but in the presence of some other disorders (chorionepithelioma, hydatidiform mole, para-ovarian cyst, embryonal adenocarcinoma or missed abortion) these biologic tests produce a misleading positive result. Because forty-eight hours must elapse before the result is known, these tests cannot be used in emergencies.

The Aschheim-Zondek test or any of its modifications may be of value in atypical cases where diagnosis is questionable. In such cases, if the results are negative, it is necessary to await further developments, but the patient should be in the hospital under observation until the diagnosis can be established. Such temporizing sometimes prevents unnecessary operation. On the other hand, some patients may require immediate intervention. Therefore, each patient should be prepared for operative interference in case emergency arises.

In our series the Friedman modification of the Aschheim-Zondek test was done in fifty-three cases (30.6 per cent). In forty-three patients (24.9 per cent) the test was positive; in eight instances (4.6 per cent) it was negative and in 2 cases (1.2 per cent) the rabbits died and the patients were operated upon before

the test could be repeated. Since the majority of our patients were admitted to the hospital as emergencies, there was not sufficient time for an Aschheim-Zondek test. When it was possible to do a biologic test, it was often necessary to operate before the report from the laboratory was received.

Falls-Freda Test. This is a skin reaction test which yields a result thirty minutes after the subcutaneous injection of colostrum. In a pregnant patient no skin reaction takes place. If the patient is not pregnant, a marked redness around the site of injection persists for two to three hours. Frederick H. Falls (1941), one of the workers who developed this test, found it reliable in 85 per cent of the cases in which it was used. Casler prefers this procedure to the longer and more expensive Aschheim-Zondek and Friedman tests.

Puncture of Douglas' Pouch. Aspiration of Douglas' pouch is a relatively simple procedure which can be performed in a short time in the home, in the physician's office or in the hospital. If blood is aspirated, it usually indicates intraperitoneal bleeding. However, in one of my patients in whom aspiration of the cul-de-sac was employed, laparotomy revealed that there was no blood in the peritoneal cavity; blood was evidently obtained from a varicose vein.

Burch and Seitchik, who consider aspiration of the cul-de-sac the most valuable single diagnostic aid in ectopic gestation, recommend abdominal aspiration if vaginal puncture is not advisable. These authors examine peritoneal blood for color, viscosity, presence of small clots and clotting time.

Authorities differ on the diagnostic value of cul-de-sac puncture. Mathieu believes it is important from the standpoint of treatment as well as diagnosis to know the character of fluid which is palpated in this region. Ware and Winn (1946) do not believe in this procedure because they say blood cannot be aspirated from an organized clot and the procedure increases the danger of infection. Schauffler and Wynia punctured the cul-de-sac in twelve of their cases without untoward effects and with definite positive results in eleven instances. They consider the procedure diagnostically valuable.

Falls (1941) subscribes with emphasis to the diagnostic value of cul-de-sac puncture. He has set down five conditions which should be met before the procedure is undertaken: (1)

There should be a mass in the cul-de-sac sufficiently definite to indicate the direction of the diagnostic puncture. (2) The aspirating needle must be of sufficiently large bore to permit the passage of slightly clotted blood. Burch and Scitchik use a number 17 needle which they say permits withdrawal of small clots. (3) The vagina should be very carefully prepared as for a vaginal hysterectomy to avoid the possibility of carrying infection into the hematocele. (4) The needle should penetrate only as far as the hematocele and as soon as old blood is obtained, no further exploration should be attempted. (5) Even a small amount of liquid or clotted old blood should be interpreted as being sufficient evidence of ectopic pregnancy to indicate exploratory laparotomy even in the absence of other evidence of ruptured ectopic pregnancy.

Uterine fibromyomas, retroverted uteri and prolapsed adherent adnexae preclude the possibility of reaching the cul-de-sac but, of course, these conditions are apparent on pelvic examination.

Posterior Colpotomy. This procedure is only occasionally of diagnostic assistance. It differentiates pelvic hematocele from other cul-de-sac masses, such as abscess. Torpin (1944) makes liberal use of this confirmatory diagnostic aid. He states the affected tube can be removed through the colpotomy incision or through a laparotomy incision following suture closure of the colpotomy opening. Allen favors this technic for the same reason. He reports that when the affected tube or ovary is removed *per vaginam*, the length of hospitalization, the postoperative discomforts and the maternal risk are greatly reduced. DeLee and Greenhill (1943) recommend the frequent employment of this diagnostic aid. It permits drainage of any infected condition of the peritoneum. However, this is a more formidable procedure than puncture and aspiration of the cul-de-sac and convalescence may be stormy because of the possibility of excessive bleeding and infection due to excellent cultural conditions.

Uterine Curettage. To make an absolute diagnosis of ectopic gestation by means of uterine curettage, the curettement should yield chorionic villi. The absence of chorionic villi indicates: (1) ectopic gestation; (2) site of nidation was missed in the curettage and (3) the chorionic villi degenerated and sloughed away. However, one must always consider the

possibility of *combined* simultaneous intra-uterine and extra-uterine gestation.

In urgent cases there is no time for curettage. The procedure has its dangers for in the presence of tubal abortion or partial tubal rupture it may result in fatal massive intra-peritoneal hemorrhage.

Because of the confusing picture it may present and because the physician is often working against time, uterine curettement has limited value as a diagnostic aid in ectopic gestation.

Peritoneoscopy. This procedure can be of value in differential diagnosis and while it is more ambitious than puncture of Douglas' pouch, it involves no risks when carried out by a skilled technician. However, it is not a simple procedure and its use should be restricted to those who are familiar with the insertion of the instrument and who are competent to evaluate what it reveals. Scheffey prefers peritoneoscopy to either cul-de-sac puncture or posterior colpotomy.

Hysterosalpingography. The injection of opaque media into the uterus followed by x-ray examination in cases of suspected abdominal gestation reveals conclusively the presence of an extra-uterine pregnancy. A roentgenogram of an abdominal gestation without the injection of an opaque substance into the uterus will often reveal a living or a dead fetus in an abnormal position, but it will not prove that the gestation is extra-uterine. (Fig. 19, Case vi.)

When a roentgenogram reveals an apparently dead fetus (collapsed skull with or without other signs of fetal death) and there is strong suspicion of ectopic gestation, there is no danger in injecting opaque media into the uterus whether the pregnancy is intra- or extra-uterine. Hysterography is advisable when the fetus is dead and all attempts to bring about its expulsion by medicinal and mechanical means fail.

If the fetus is alive and the diagnosis is doubtful, injection of an opaque substance into the uterus may produce abortion should the pregnancy be intra-uterine. As previously stated, a low voltage roentgenogram may show that the uterine wall does not surround the fetal parts. (Fig. 23, Case vii and Fig. 27, Case viii.)

Mathieu recommends hysterosalpingography to differentiate between ectopic gestation and

rupture of a graafian follicle or corpus luteum. Falls (1941) advocates this procedure to establish a diagnosis when interstitial or abdominal pregnancy or lithopedion is suspected. Torpin (1944) does not favor x-ray examination because of the time it requires and because he believes it frequently yields indecisive results. Beacham and Beacham in their study of abdominal pregnancy observed no gestations that were disturbed in procuring uterograms or uterosalpingograms.

Hysterosalpingography like tubal insufflation may be followed by ectopic pregnancy. The tube becomes patent but is still not healthy, and the same factors that operate in any abnormal tube may persist after hysterosalpingography or insufflation. In other words, the peristalsis of the tube may be affected; the tubal mucous membrane may be so pathologically altered that ectopic gestation is likely to occur. If the irritation produced by ordinary opaque media had increased the incidence of tubal pregnancies, we would have had a far larger number of such gestations, as thousands upon thousands of women have been subjected to hysterosalpingography and have subsequently had normal uterine pregnancies.

In my experience hysterosalpingography done with opaque media not readily absorbable has not been responsible for tubal pregnancies. In such cases pre-existing pathologic conditions of the tubes were responsible.

Urobilinogen and Icterus Index Tests. Since these tests reveal the presence of a large hematoma or of blood undergoing absorption, they may be useful as differential diagnostic aids. Icterus accompanied by a rise in temperature signifies decomposition of the products of gestation. Mathieu found these tests valuable in arriving at a correct diagnosis in ectopic gestation.

DIFFERENTIAL DIAGNOSIS

The numerous incorrect preoperative diagnoses reported in the literature afford abundant evidence that ectopic gestation produces symptoms similar to those of many other pelvic and abdominal conditions.

In this series 159 (91.9 per cent) of the 173 cases were correctly diagnosed preoperatively. The remaining fourteen cases (8.1 per cent) were incorrectly diagnosed as indicated in Table vi:

In the experience of other authors it is of interest to note the percentage of correct preoperative diagnoses as shown in Table VII:

According to Novak (1944) the percentage of error reported by all authors varies from 15 to 35 per cent. DeLee and Greenhill (1947)

TABLE VI

Preoperative Diagnosis	No. of Cases	Postoperative Diagnosis
Appendicitis............	4	Right ruptured tubal pregnancy
Diseased adnexa.......	1	Right ruptured tubal pregnancy
Diseased adnexa and fibromyoma of uterus.	1	Left unruptured tubal pregnancy and fibromyoma of uterus
Submucous fibroid of uterus.	1	Submucous fibroid of uterus and right unruptured tubal pregnancy
Ovarian cyst..........	1	Left unruptured tubal pregnancy
Ovarian cyst..........	1	Left tubal pregnancy and right hematosalpinx
Incomplete abortion....	2	Right ruptured tubal pregnancy
Incomplete abortion....	1	Right ruptured tubal pregnancy and left hydrosalpinx with left ovarian cyst
Intestinal obstruction..	1	Right ruptured tubal pregnancy
Intra-uterine pregnancy with fibromyoma of uterus.	1	Left ruptured tubal pregnancy (isthmial) and fibromyoma of uterus

TABLE VII

Series	No. of Cases	Per cent
Fitzgerald and Brewer.............	500	60.4
Langman and Goldblatt...........	310	81.3
Marchetti et al....................	141	87.9
Nucci.........................	150	79.4
Schauffler and Wynia.............	65	80.0
Torpin (1944)....................	80	88.7
Ware and Winn (1946)............	115	89.0

believe that "no pelvic condition gives rise to more diagnostic errors." Yet Titus maintains that even before rupture or abortion tubal gestation no longer presents unusual diagnostic difficulties. Errors that occur result from failure to differentiate this protean condition from other pelvic or abdominal entities presenting a similar prodromal picture. Many pathologic states which simulate ectopic gestation are also fulgurant abdominal emergencies (acute appendicitis, perforation of a gastric or a duodenal ulcer, rupture of a pus tube, rupture of the spleen) and the immediate surgical intervention which they demand settles all diagnostic questions.

Differential diagnosis is necessary chiefly in the atypical case in which vague and limited symptoms mask an unruptured ectopic pregnancy, a slow-leaking rupture or a walled-off hemorrhage. The surgeon of today will agree with Lawson Tait's observation, "The diagnosis of tubal pregnancy before rupture of the tube is not easy . . . because the patients do not claim our attention."

On the other hand, the clinical picture in typical ectopic pregnancy is usually sufficiently clear that a correct preoperative diagnosis can be established promptly. This, of course, is fortunate because, with the patient's life hanging in the balance, there is no time for the employment of diagnostic aids, many of which are time-consuming. Again Tait's remark is timely: "The diagnosis of tubal pregnancy at the time of rupture may be made with certainty seven times out of eight, and may be guessed at in the eighth instance."

All patients suspected of having an ectopic gestation should be kept under observation in the hospital until a differential diagnosis is established. Such a procedure will often change an erroneous admission diagnosis to a correct preoperative one.

Even the most experienced and skillful surgeon cannot avoid occasional diagnostic errors in ectopic gestation because of concomitant pathologic conditions frequently encountered, the vagaries of symptoms and the similarity of this condition to other obstetric and gynecologic states (Nucci). Whenever there is doubt about the diagnosis and temporizing seems justified, the surgeon has a number of diagnostic aids at his disposal.

According to Torpin (1945) the three most common causes of diagnostic error, in the approximate order of their incidence, are salpingitis, uterine abortion and appendicitis. Mathieu considers acute appendicitis, salpingitis and twisted ovarian cyst the most frequent conditions necessitating differential

FIG. 22. Case VI, V. M. Abdominal pregnancy. The fetus shows a large frontal protuberance. The sac is formed by both the fallopian tube and the ovary. This is the same case as shown in Figures 20 and 21.

diagnosis. Chronic salpingo-oophoritis is often a cause of difficulty in differential diagnosis. Common conditions necessitating differential diagnosis from ectopic gestation follow:

Abortion, Uterine. The symptoms of early pregnancy and hemorrhagic vaginal discharge characterize this condition. The bleeding lasts longer and is more profuse than in ectopic gestation. The blood is bright red. Occasionally placental tissue is passed. Unilateral mass and abdominal tenderness are absent. The uterus is apt to be softer and its size will correspond to the duration of amenorrhea. The pain is less severe and is referred to the midline rather than to one side. Novak (1944) advocates the use of pelvic puncture as a diagnostic aid. The presence of considerable blood indicates ectopic gestation. Curettage where chorionic villi are not found favors ectopic pregnancy. Curettage is to be done with great care because of the danger of massive hemorrhage should a partial rupture or tubal abortion have occurred.

Angular pregnancy is located in one horn of the uterus. The affected side becomes distended. According to DeLee and Greenhill (1947) this condition is a frequent cause of incorrect diagnosis and it cannot be distinguished "from interstitial pregnancy except by the clinical course."

Appendicitis occasions many diagnostic errors in cases of ectopic gestation. The symptoms of early pregnancy are absent. Diagnostic error often occurs when the menstrual period coincides with severe pain in the right lower quadrant, accompanied by rigidity of the right rectus muscle and leukocytosis. At the onset, however, pain is usually localized around the umbilicus or in the epigastrium. The nausea and vomiting of appendicitis may also add to the diagnostic confusion. Appendicitis may occur in early pregnancy; and if there is any question about the diagnosis, laparotomy should be performed.

Corpus luteum rupture may result in intra-peritoneal hemorrhage with pain and sometimes shock, thus simulating ectopic rupture. I have encountered two cases of this type.

While on her honeymoon, and before she had had sexual relations, one of my patients developed signs of intra-abdominal bleeding. To their dismay, the young couple was informed that the wife required immediate operation for hemorrhage caused by ruptured

extra-uterine pregnancy. However, laparotomy revealed extensive hemorrhage from a ruptured corpus luteum.

The second case was that of a patient who came to me with a history of having been operated upon six weeks previously for ruptured graafian follicle with severe hemorrhage and removal of the right ovary. Her statement was confirmed by the surgeon who performed the operation. I treated her for sterility and two years later delivered her of twins.

The sudden onset of severe lancinating lower abdominal pain, sometimes unilateral, sometimes generalized; abdominal tenderness and rigidity, perhaps accompanied by anemia, signs of massive abdominal hemorrhage, peritoneal irritation, nausea, vomiting and shock, all of which may be encountered in spontaneous rupture of the corpus luteum, may cause the condition to simulate ectopic gestation. Shock is out of proportion to the blood loss. Fever and leukocytosis are usual. On examination there is generalized vaginal sensitivity. Corpus luteum rupture usually takes place immediately before the onset of the menses. Any diagnostic question can be settled by puncture of the cul-de-sac. If blood is found, ectopic gestation cannot be excluded.

Cysts. Marchetti et al. attributed some of their diagnostic errors to four types of ovarian cysts: corpus luteum cysts, simple serous cysts, cysts with twisted pedicle and endometrial cysts.

A *corpus luteum cyst* presents many symptoms of an unruptured tubal pregnancy or of a tubal abortion. The Aschheim-Zondek test is falsely positive. There may be menstrual delay, followed by the hemorrhagic vaginal discharge characteristic of ectopic gestation. The enlarged ovary presents a tender unilateral mass, simulating the mass of tubal gestation.

Endometrial (Chocolate) Cyst. Because of the marked resemblance between the two conditions, macroscopic examination frequently fails to distinguish ovarian pregnancy from endometrial cyst (Wilson and Robins).

Ovarian cyst with twisted pedicle may give rise to diagnostic confusion. The sudden, severe pain accompanied by nausea and vomiting may occur in both conditions, *i. e.,* in ovarian cyst with twisted pedicle and in ectopic rupture. In the former condition the twisted pedicle is responsible for these symptoms. While there

is no history of amenorrhea in ovarian cyst, this symptom is likely to be present in ectopic gestation. Frequently the history includes prolonged menstrual irregularity and the existence of an ovarian cyst, which may be palpated on abdominal examination. If time would permit, biologic tests would be of assistance because their result would be negative. However, as ovarian cyst with twisted pedicle is a condition that usually demands immediate surgical intervention there is no time to employ these diagnostic aids. Mathieu considers twisted ovarian cyst one of the most common pathologic states to be distinguished from ectopic gestation.

Fibromyomas are reported by many authors as a cause of incorrect diagnosis in ectopic gestation. In my experience fibromyomas are often associated with other pathologic conditions: inflamed adnexae, cystic ovaries or ovarian cysts of varying sizes, abortion, and when least suspected unruptured ectopic gestation of recent or long-standing origin. In general, when there are masses in the pelvis the uterus is likely to remain unchanged except for slight enlargement in the early weeks of ectopic gestation or when myomas of the uterus are present.

Graafian Follicle, Ruptured. The pain, intraperitoneal hemorrhage and shock accompanying this condition, which usually takes place at the *mid-menstrual interval* make it very difficult to differentiate from ectopic gestation. A uterosalpingogram is of great assistance in establishing the diagnosis. It will exclude tubal gestation but will not exclude early primary ovarian pregnancy.

Hematosalpinx. Many cases of hematosalpinx are undiagnosed ectopic pregnancies. Although the history of the patient may be at variance with the findings, I believe that in encountering hematosalpinx the first thought should be of ectopic gestation. Even at laparotomy cases of hematosalpinx cannot always be differentiated grossly from tubal pregnancy. (Case v.)

In this case the history was not typical of ectopic gestation. Before operation a diagnosis of ovarian cyst was made. When the abdomen was opened a hematosalpinx was found. Grossly and microscopically there was no indication of ectopic pregnancy; the tube showed chronic inflammatory reaction and thickening. However, in many sections of the blood clot degenerated chorionic villi were found. (Figs. 17 and 18.) Unfortunately, a biologic pregnancy test was not done since ectopic pregnancy was not suspected. Had a biologic test been made, the result might have been negative because the chorionic villi were degenerated and detached from the tubal wall; in all probability the trophoblasts were not functioning.

In another patient operated upon for ectopic pregnancy a left ruptured tubal pregnancy and a right hematosalpinx were found. It is my impression that this case was a bilateral tubal pregnancy. Grossly the left tube showed a fetus and sac. No fetus was found in the right tube. Evidently a thorough microscopic examination was not done in this case because of the exigencies of war. Therefore, there was no conclusive evidence that there was a pregnancy in the right tube.

Hematoma or Hematocele, Infected. These conditions make differentiation from pelvic cellulitis, perimetritis or pyosalpinx virtually impossible without cul-de-sac puncture or colpotomy to demonstrate the hemorrhagic character of the pelvic mass. Jaundice is a valuable diagnostic aid since it is usually concomitant with autolysis of blood.

Hydrosalpinx. The presence of fluid in the tube gives rise to distention which may cause severe pain and present a tubal outline simulating that of ectopic gestation.

Intra-uterine Gestation, Complications. Several conditions accompanying a normal intrauterine gestation present a symptom complex which causes the surgeon to suspect ectopic pregnancy. These include ovarian cyst, fibromyomas, soft uterine wall with an extreme lateral rotation, pregnancy in a retroflexed uterus and a large corpus luteum. A retroverted gravid uterus, like a pelvic hematocele, may be accompanied by anuria. If there is in addition some hemorrhagic vaginal discharge caused by threatened abortion, the suspicion of ectopic gestation increases. The passage of a catheter will at times clear up any diagnostic doubt because it permits more satisfactory uterine palpation.

Pancreatitis, Acute. The onset of this condition with its sudden, severe abdominal pain and distention, vomiting, nausea and abdominal tenderness may result in an incorrect diagnosis of ectopic gestation.

Pelvic Inflammatory Disease. Many writers report some diseased condition of the pelvic

organs as a cause of diagnostic confusion in ectopic gestation. Gonorrheal salpingitis is the most common offender. As Nucci points out, the cause of this confusion is to be found in the fact that two of the most universal symptoms of ectopic gestation—abdominal pain and hemorrhagic vaginal discharge—occur also in salpingitis. However, the complete symptom complex of each condition possesses a sufficient number of dissimilar features to enable the physician to make a correct diagnosis in spite of any common signs encountered.

The pain in gonorrhea usually coincides with or immediately follows the menses. It is unremitting whereas ectopic pain is usually intermittent. While there may be a hemorrhagic vaginal discharge, this is not so frequent as that encountered in ectopic gestation.

In gonorrhea the physical examination usually reveals a bilateral adnexal mass although the mass on one side may be much larger than on the other, giving the impression of a unilateral formation (Novak, 1944). In gonorrhea there is lower abdominal rigidity; but in ectopic gestation, if rigidity is encountered, it is restricted to the side of the pregnancy.

Laboratory tests will often clarify the diagnosis. Smears taken from the urethra and cervix, also cultures for gonococci are of great value. Gonorrhea is apt to produce a more rapid sedimentation rate than ectopic gestation. In ectopic gestation the leukocyte count is usually under 15,000, but in salpingitis the usual count is between 15,000 and 20,000. The temperature in pelvic inflammatory disease may rise to 103°F., but in ectopic pregnancy it seldom runs above 102°F. Farrar emphasizes the value of the fluctuating leukocyte count along with a slightly raised temperature in differentiating ectopic gestation from a purulent salpingitis. She found that the latter condition presents a more uniformly high leukocyte count and fluctuating temperature. In the presence of pregnancy the biologic tests are frequently positive whereas in gonorrhea they are negative. Blood in Douglas' pouch should rule out salpingitis. However, in one of my cases, aspiration of the posterior cul-de-sac brought out blood; immediate laparotomy revealed subacute adnexitis.

According to various authors the following conditions may present symptoms which necessitate differentiation from ectopic gesta-

tion: Carcinoma of fundus; carcinoma of ovary; cholecystitis; chorionepithelioma; dermoid cyst and intra-uterine pregnancy; endometrioma; hematoma of the rectus muscle; ileus; intestinal obstruction and intra-uterine pregnancy; myopathic bleeding; nephrolithiasis; ovarian hemorrhage; painful ovulation; pelvic abscess; perforation of a gastric or a duodenal ulcer; perforation of the stomach or duodenum; pregnancy in a bicornate uterus; primary anemia; renal colic; ruptured appendiceal abscess; ruptured follicular cyst; ruptured gallbladder; ruptured pyosalpinx; ruptured spleen; ruptured splenic artery; ruptured varicosities of broad ligament; tuberculous peritonitis; tubo-ovarian abscess; twisted ovarian tumor; twisted tube or ureteral stricture and ovarian cyst.

Cervical Pregnancy. A correct preoperative diagnosis is rare in cervical pregnancy. This type of gestation may be erroneously diagnosed as uterine abortion, placenta previa, cancer of the cervix, ruptured ectopic gestation, early uterine pregnancy complicated by fibroids, hematoma of the cervix and cervical fibroid (Studdiford, 1945).

The symptoms are most frequently interpreted to indicate some stage of uterine abortion. In the latter condition, however, painful uterine contractions and hemorrhages precede detachment of the ovum (Sehneider).

PATHOLOGIC ANATOMY

Lawson Tait, an outstanding pioneer in the field of extra-uterine pregnancy, was of the opinion that all ectopic gestations, with the possible exception of ovarian, must, in their origin, be tubal.

J. C. Webster, another leading authority, contended that in the light of knowledge then existing there were but three types of ectopic gestation: ampullar, interstitial and infundibular. It was his belief that as research into the subject progressed, other classes of extra-uterine implantation might be demonstrated. This opinion has been borne out during the intervening years, and newer knowledge has definitely established that an aberrant fertilized ovum can nidate in the tube, ovary, abdominal cavity (peritoneum) and, in extremely rare instances, in the cervix. In fact, as Kerr states, it is possible for the ovum to become implanted anywhere in the pelvic or abdominal cavity.

Sites. Extra-uterine gestations may be classified as tubal, ovarian, abdominal and cervical, but all authorities agree that the most frequent site for nidation of the ectopic ovum is the interior of the tube (Fig. 1) where it may take place either in the tubal wall (intra-

TABLE VIII

Location	No. of Cases	Per cent
Isthmus	57	35.8
Ampulla	51	32.1
Entire tube (including hematosalpinx containing products of conception)	17	10.7
Fimbria	12	7.5
Abdominal cavity	9	5.7
Interstitial portion of tube	8	5.0
Cornu	2	1.3
Tubo-ovarian: fimbria-ovarian	2	1.3
Rudimentary horn	1	0.6

columnar) or in a tubal fold (columnar). Woodhouse states that of all ectopic pregnancies, 95 to 98 per cent are found to be tubal pregnancies.

ectopic ovum may lodge and begin its development as follows: (1) ampulla; (2) isthmus and (3), the interstitial portion of the tube. In rare cases, implantation may occur upon (4) the fimbriated extremity and sometimes upon the (5) tubo-ovarian (fimbria ovarica). Titus lists ovarian pregnancy as the sixth type of extra-uterine gestation and abdominal pregnancy as the seventh type.

While authorities differ on the relative incidence of all types of tubal implantation, the overwhelming consensus of opinion favors the ampulla as the site of greatest frequency. The great width of the tube at this point and the excellent vascular supply are in all likelihood responsible for the high proportion of ampullary nidations (Kerr). The isthmus is second choice for tubal nidation. Implantation in the fimbriated extremity and in the interstitial portion is of low frequency.

In nine series totaling 1225 cases of ectopic gestation, the frequency of occurrence was as follows: ampulla, 578; isthmus, 265; fimbriated extremity, 71; interstitial portion, 45; infundibular, 31; entire tube (including hematosalpinx containing products of conception), 17; ab-

TABLE IX
LOCATION OF ECTOPIC OVUM IN 1225 CASES
(As Reported by Nine Authors)

Series	No. of Cases	Ampulla	Isthmus	Fimbriated Extremity	Interstitial Portion	Infundibular	Entire Tube	Abdomen	Distal Half of Tube	Distal Two-thirds of Tube	Broad Ligament	Entire Tube and Ovary	Ovary	Cornu	Tubo-ovarian	Rudimentary Horn
Falk and Rosenbloom	313	165	34	..	14											
Foskett	117	52	64	..	1											
Jarcho	173	51	57	12	8	..	17	9	.	..	..	..	..	2	2	1
Lise et al	115	75	26	..	7	..	..	3	.	..	..	..	2			
MacFarlane and Sparling	110	67	32	.	7	..	.	3								
Nucci	150	62	23	59	1	.	.	2	..	..	..	..	2			
Sadler	102	32	17	..	3	..	..	..	1	6	5	5				
Schauffler and Wynia	65	9	14	..	1	31	..	..	..	..	..	..	..	1		
Torpin	80	65	8	..	3	..	..	..	.	..	..	..	1			
Totals	1225*	578	265	71	45	31	17	17	10	6	5	5	5	3	2	1

* Includes 164 cases in which site was not stated, or, if stated, not proven.

In 159 cases (91.9 per cent) in this series the ovum was located at the site indicated in Table VIII:

The tubal pregnancy occurred on the right side in ninety cases (52.0 per cent), on the left side in seventy-three cases (42.2 per cent) and was bilateral in one case (0.6 per cent). In nine cases (5.2 per cent) the ectopic pregnancy occurred in the abdominal cavity.

Titus outlines the various sites where an

domen, 17; distal half of tube, 10; distal two-thirds of tube, 6; broad ligament, 5; entire tube and ovary, 5; ovary, 5; cornu, 3; tubo-ovarian, 2, and rudimentary horn, 1. The site in the remaining cases was not stated, or, if stated, not proven. (Table IX.)

Although tubal implantation is by far the most common ectopic type, the occurrence of primary implantation in the ovary, peritoneal cavity and cervix is now generally conceded

by leading pathologists. Ectopic gestation has also been known to occur in an endometrial pocket in the wall of a uterus harboring adenomyosis (Doederlein and Herzog).

The most significant difference between uterine and extra-uterine gestations is found in their decidual formations. The uterine decidua is a thick, massive membrane, admirably adapted for its ordained function. Its structure enables it to shelter the ovum, to protect the uterine musculature from the erosive action of the trophoblast, to provide for the formation of the decidua capsularis and to nourish the ovum until a normal placental circulation is established from small blood vessels.

In ectopic gestation, on the other hand, decidual reaction is imperfect, scanty and incomplete. The pathologic changes brought about by this condition are determined by the site of implantation and the length of time which elapses before trophoblastic erosion into large, unguarded blood vessels causes uncontrollable hemorrhage.

The ovum nidates in an ectopic nidus in the same manner in which normal implantation occurs, i.e., when the trophoblast has developed it erodes into the nearby mucous membrane. There it encounters an anatomic structure different from that in the uterus and its pathologic course is influenced thereby.

Ectopic gestation may terminate in: (1) Early death of the embryo, with complete absorption of the products of gestation. (Case v); (2) development to an advanced stage or, less frequently, to term, in the site of primary nidation. (Cases vi, vii, viii and ix); (3) rupture.

If rupture occurs, three courses are open to the ovum: (1) It may perish; (2) it may continue development in the site of secondary implantation (Case iv); or (3) although rupture may change its position, its placental attachments may not be disturbed and development will continue in the site of primary nidation (H. E. Miller).

Grier states, "One should keep in mind the pathology as it appears in the three different phases, namely, before rupture, at the time of rupture, and sometime after rupture. Each has its own peculiar picture."

Pathologic Changes in Tubal Gestation. Because the uterus and tubes are both derived from Müllerian tissue, their physiologic reaction to gestation is the same; but because the anatomy of the tube cannot accommodate a developing ovum, the result of tubal nidation is always pathologic. Damage to the blood vessels is the most significant pathologic feature of tubal pregnancy (Kerr).

In uterine gestation the blood vessels of the uterine musculature are not eroded. Tubal gestation, however, lacks a true decidua and submucosa; hence the ovum penetrates the mucous membrane and almost at once meets the inner tubal muscular layer. The ovum penetrates large unprotected vessels, producing hemorrhage. This tubal hemorrhage is often so great that the villi are disrupted and the ovum capsule so overdistended that the blood pours forth into the wall or peritoneal cavity. Or there may be rupture of the internal capsule into the tubal lumen—the condition usually referred to as tubal abortion. Litzenberg (1937) says, "From this same source, blood extravasates into the capsularis and between the muscle fibers along the tube wall, toward the fimbriated extremity or toward the uterus." In his wide experience he never examined an ectopic tube in which there had not been intracapsular hemorrhage. Rock says, "The aperture through which it [the ovum] enters closes over it, and it becomes completely surrounded by maternal tissue. Thus failing to grow on the surface, it forces the maternal envelope to stretch almost indefinitely, a quality possessed only by the uterus, the peritoneum, and sometimes the ovary."

From the nutritional standpoint the tube is an unfavorable nidus and the ovum usually perishes in the early weeks. According to Te Linde tubal abortion occurs, as a rule, between the sixth and twelfth weeks of pregnancy. Whether an ectopic pregnancy will continue as a secondary implantation is determined by the condition of the ovum and the extent of hemorrhage at the time of rupture (Beacham and Beacham). According to Rock in over 80 per cent of cases fetal death precedes or is approximately coincidental with the appearance of symptoms. Bleeding into the peritoneal cavity results in a hematocele; bleeding into the tubal lumen causes hematosalpinx.

Many cases of hematosalpinx are undiagnosed ectopic pregnancies. When encountering a hematosalpinx, I am of the opinion, as previously mentioned, that the first thought should be of the possibility of an ectopic gestation.

In tubal gestation there is a capsularis, but, as Litzenberg says, it cannot be termed decidua capsularis because decidual reaction is so sparse. The tubal capsularis is fundamentally weak; it does not stretch or develop. What strength it possesses is reduced by the attacking villi, making it easy prey to rupture.

Writers are in general agreement (Novak, DeLee and Greenhill, Kerr, Litzenberg) that there is very little decidual reaction in the tube and few decidual cells are present. What decidual reaction is demonstrable is imperfect and unlike the characteristic uterine decidua. Investigators who report the presence of numerous decidual cells undoubtedly mistake these for trophoblast cells. As Novak (1947) states: "The trophoblast can, in properly cut sections, be traced by direct continuity far out into the tubal wall, and there is no doubt that these invading cells have often been mistaken for decidua." Litzenberg (1937) points out that decidual reaction is sparsest at the site of nidation. It becomes more abundant the farther one goes from this point. It may be observed in the tubal peritoneum and in the fimbriated extremity. J. Whitridge Williams (1920) observed the most pronounced tubal deeidua in the opposite non-gravid tube.

In some cases Litzenberg (1937) noted thickening of the tubal musculature in the vicinity of the implantation. The rest of the tubal musculature undergoes very little change except where the enlarging ovum extends it.

Microscopically, tubal gestation is evidenced by the presence of chorionic villi in the tubal lumen and on occasion in the wall. The villi may be quite normal in appearance or they may reflect pronounced degeneration and hyalinization (Novak, 1944). When manifesting minor evidence of change, the Langhans and syncytial cells comprising the trophoblastic epithelium can be readily distinguished. (Figs. 3, 4, 5, 6, 7 and 8, Case II; Figs. 11, 12 and 13, Case III and Figs. 17 and 18, Case V.)

The ovum grows rapidly and in the absence of a protective decidua, its behavior simulates that of a malignant neoplasm (DeLee and Greenhill, 1943). Columnar nidation eventuates in what is really a gravid polyp which of necessity is short lived (Litzenberg, 1937). The hypertrophy of the tubal musculature is unable to accommodate the enlarging ovum and eventually, as a result of the destructive action of the villi, a weak spot develops at the

placental site. Then some unusual pelvic exertion, such as stretching, coitus, defecation, the use of abortifacients and sometimes vaginal examination may bring on a rupture with hemorrhage; or the tube may break from overdistention of its thin, eroded wall and the villi lie at large in the peritoneum, causing an extracapsular rupture. If rupture is on the free part of the tube, the escaping blood may collect gradually in Douglas' cul-de-sac or elsewhere in the pelvis. When the blood so amassed becomes encapsulated by peritoneal adhesions, a pelvic hematocele is formed. This is by far the most frequent termination of tubal gestation. Rupture of the tube into the broad ligament is of rare occurrence, but when it does take place a hematoma is formed there and the ovum usually perishes. More infrequently it may continue to develop. In this case the broad ligament becomes very much separated, the peritoneum is stripped off both bladder and rectum, and pushed up by the growing sac. The sac of this gestation seldom ruptures because it is firmly adherent to the neighboring structures (Kerr).

Leading authorities (Frank, Watson, Litzenberg, 1937) have questioned the distinction between the terms tubal abortion and tubal rupture as terminations of tubal gestation. Watson maintains that the two conditions are basically the same and a tubal abortion must be preceded by a tubal rupture: "In both cases the ovum ruptures through the tube wall, through the peritoneal aspect, or through the mucous membrane into the lumen" (Watson). Watson is of the opinion that while the clinical picture is less acute when rupture takes place in the lumen, the pathologic course of both processes is essentially the same.

Frank says that tubal abortion is a misnomer because it is not an abortion but an outgrowth into the lumen of the tube.

Litzenberg (1937) maintains that "internal rupture" is more accurate than "tubal abortion" because the latter, strictly speaking, is a separation of the ovum and its expulsion by the action of the tubal musculature. He doubts very much whether an ectopic tube, weakened by erosion and distention, has the power to extrude even a detached ovum. In his judgment if an ovum is expelled, the expulsion will be by hemorrhagic force. This authority prefers the terms external tubal rupture and internal tubal rupture to tubal .

rupture and tubal abortion, respectively. I concur fully with his opinion.

While hemorrhage is characteristic of both intra-uterine abortion and internal tubal rupture, its origin and cause are different. In intra-uterine abortion hemorrhage is the result of separation of the ovum and the blood originates *beneath* the uterine decidua or placenta. In internal tubal rupture the inner ovum capsule breaks because of overdistention and the blood issues from large penetrated blood vessels.

In the experience of Schumann tubal rupture occurs twice as often as tubal abortion, and in that of Lavell, over three times as frequently. Hemorrhage, as a rule, is less severe in the condition termed abortion and may terminate with complete extrusion of the embryo. These atypical cases of complete embryonic expulsion sometimes result in spontaneous recovery. In incomplete embryonic abortion a slow hemorrhage from the tubal ostium persists, eventually forming a pelvic hematocele with symptoms necessitating surgical intervention.

In tubal rupture hemorrhage may persist whether the ovum has been expelled or not. The extent of intraperitoneal hemorrhage is not affected by the location of the rupture. Repeated rupture is the rule (Gordon, 1936). Blood, a peritoneal irritant, causes pain; hence, pain signifies rupture.

Most writers use the term unruptured tubal pregnancy to designate a tubal condition in which the tubal wall is intact. According to Litzenberg (1937) this designation is erroneous because even though no break in the tube can be detected, blood seeping through the ostium abdominale is proof of rupture of the internal embryonic capsule. He holds that blood in the peritoneal cavity is evidence that the ovum capsule is ruptured either externally or internally.

Ampullar Gestation. When nidation occurs in the ampullary portion of the tube, the pregnancy usually terminates in tubal abortion. Hemorrhage separates the ovum from its placental site, the sac may rupture and the fetus is extruded into the tubal lumen (DeLee and Greenhill, 1943). This process is known as intracapsular rupture. Blood seeps through the fimbriated extremity of the tube, slowly coagulating to form a lower pelvic hematocele. Eventually the ovum and blood clots are projected through the tubal opening into the abdominal cavity where they are finally absorbed unless removed by the surgeon. Occasionally an ampullary pregnancy may continue as a secondary abdominal gestation, provided that sufficient placental tissue remains attached to the tube. According to DeLee and Greenhill (1943) if the ovum remains in the tube, it gradually succumbs to hemorrhage and is converted into a *mola carnosa*. The mole may rupture but more often it disintegrates and forms a hematosalpinx. This condition is responsible for continued abdominal discomfort and irregular menstruation. Sometimes, although rarely, a pyosalpinx may form (Kerr).

Isthmial Gestation. Because the muscle fibers are not well developed and because the tubal lumen is too small at the isthmus to permit expansion of the fetal sac, gestations in this portion of the tube usually terminate by rupture with the formation of a pelvic hematocele, sometimes, according to Kerr, as early as the second or third week.

Interstitial Gestation. Far less frequent than ampullar and isthmial implantations, interstitial gestation is of marked interest, not only because of its relatively low incidence but also because it produces certain perils and problems not encountered in the more common forms. The greater vascularity of this part of the tube makes it the most hazardous site for a tubal pregnancy. (Figs. 9 to 13, Case III.)

While this type of nidation has been divided into groups, Wynne says that the simplest classification is: tubo-interstitial, utero-interstitial and interstitial proper. When the ectopic ovum selects as its host the uterine wall (portion of the tube surrounded by uterine muscle), a true interstitial pregnancy comes into being.

In the typical case the ovum grows in the uterine wall and penetrates the muscle layers. "The corner of the uterus" (Kerr) is displaced, resulting in distortion of the rest of the organ (DeLee and Greenhill, 1943). While rupture usually occurs during the second and third months (Grusetz and Polayes), it may be of later occurrence. The dense layer of uterine musculature surrounding the interstitial portion of the tube provides a more suitable site for development of the ovum than is found in the tubal wall. Interstitial gestation is very rare after six months.

According to Polak interstitial gestation

may terminate in one of the following ways: (1) By death of the ovum; (2) by expulsion of the ovum into the uterus, in which case the pregnancy may terminate as an abortion or proceed and develop as an intra-uterine pregnancy; (3) by rupture into the peritoneal cavity, with death of the mother from hemorrhage and shock; (4) the ovum may rupture into the broad ligament.

Rupture may occur into the uterus; more often it occurs into the abdominal cavity. Because of the large blood vessels in this region, hemorrhage from this rupture is massive. Hematocele is a frequent accompaniment.

Wynne sets forth the following criteria for interstitial gestation: (1) A fetus or fetal elements must be found, (2) uterine muscle must surround the fetal membranes except at the region of the rupture, (3) there must be no connection with the uterine cavity unless definite evidence of a rupture into it is found and (4) the isthmus of the tube must not be involved in the sac. (Figs. 9 and 10, Case III.)

Ovarian Gestation. Although of comparatively rare occurrence, ovarian gestation is not as infrequent as it was once believed to be. Curtis states that approximately 100 cases of true or primary ovarian gestation have been reported in the literature, but only about sixty of these appear to be authentic. He goes on to state that primary ovarian pregnancy may occur after fertilization in the fallopian tube, just as normal intra-uterine gestation develops after fertilization in the fallopian tube.

Ovarian gestation may be the result of (1) fertilization of an ovum which was not extruded from the ovary upon rupture of the graafian follicle; or of (2) fertilization of the ovum outside the ovary, with subsequent ovarian nidation. The first type is probably a primary ovarian implantation; whereas the other type may be termed secondary ovarian pregnancy because it is probably the result of a rupture of the ovum into the ovary from the primary site of nidation.

Implantation on or within the ovary presents many of the clinical features of the tubal varieties. Such a pregnancy may be (Fig. 1): (1) intrafollicular, with the ovum being fertilized within the follicle; (2) superficial, with implantation occurring on the surface of the ovary; (3) interstitial, with nidation taking place in the stroma of the ovary. The intrafollicular variety is the most common.

According to Kerr this ectopic gestation terminates at a comparatively early date. Three of his cases ruptured at about the fifth, seventh and eighth weeks. While rupture with hematocele, with or without fetal death, is the usual termination, a mole, sometimes of the hydatidiform type, may form. An ovarian hematoma may not be considered the result of a gestation unless fetal parts or chorionic villi can be demonstrated (DeLee and Greenhill, 1943).

The following four criteria for primary ovarian pregnancy were first formulated by Cohnstein in 1877 and again set forth by Spiegelberg in 1878. They are generally accepted by all authorities. (1) The tube on the affected side must be intact; (2) the gestation sac must occupy the position of the ovary; (3) the gestation sac must be connected with the uterus by the ovarian ligament; and (4) definite ovarian tissue must be found in the walls of the sac.

In commenting upon the fourth criterion, J. W. Williams (1903) states that ovarian tissue should be present in several distant parts of the sac wall because in some cases of tubal or broad ligament pregnancy the ovary may in some measure be incorporated in the sac wall. (Fig. 21, Case VI; Figs. 37 and 38, Case IX.)

Abdominal Gestation. Primary abdominal nidation is of such infrequent occurrence that many authorities have doubted the possibility of its existence. Others are of the opinion that a number of authentic cases of primary implantation and development in the peritoneal cavity have been recorded. Among the cases most frequently referred to in the literature, that seem to satisfy the criteria for this type of ectopic gestation, are those of Galabin (1896); Witthauer (1903); Hirst and Knipe (1908); Reifferscheid (1922); Studdiford (1942) and R. C. Thomas (1943).

In Galabin's case there was a ten weeks' ovum in the cul-de-sac. Following removal of the gestation the patient died of hemorrhage. In Witthauer's patient the tubes and ovaries appeared to be normal, but the omentum contained a blood clot in which chorionic villi were found. In Hirst and Knipe's case the ovum was implanted on the posterior aspect of the left broad ligament. The tubes and

ovaries appeared to be normal. Reifferscheid described a fetus 1.9 cm. in length which was completely preserved and found among the intestinal loops. The ovum was covered by blood clot; its torn and collapsed amniotic cavity, corresponding to the fetus which was discovered among the intestines, was empty and was found to be firmly attached to the underlying bed of the ovum through a very fresh chorion frondosum. Decidual changes were clearly observable in the peritoneal matrix. The primitive ovum rested in a depression in the peritoneum and had eroded into it; this was analogous to uterine nidation. Meticulous macroscopic and microscopic examination of the genital organs dispelled all doubt concerning their non-participation in the pregnancy. Studdiford's case of a primary peritoneal pregnancy, reported in 1942, is probably the most impressive and least open to doubt of any on record, and greatly strengthens the possibility that this type of primary ectopic nidation may take place. The site of implantation was the posterior aspect of the uterine horn, relatively close to the interstitial portion of the tube. Because of its relationship to the peritoneum and to the interstitial portion of the tube, Studdiford is of the opinion that the gestation reached this location by primary peritoneal nidation.

Novak (1947) previously skeptical of the existence of primary peritoneal pregnancy says of Studdiford's report: "The recent case of Studdiford, however, appears to qualify as a genuine instance of primary peritoneal implantation, in this case on the posterior surface of the uterus."

Studdiford gives three criteria to prove a primary peritoneal pregnancy: (1) Both tubes and ovaries must be normal with no evidence of recent or remote injury; (2) there must be no evidence of a uteroperitoneal fistula; (3) the pregnancy must be related exclusively to the peritoneal surface and young enough to eliminate the possibility of secondary implantation following a primary nidation in the tube.

Studdiford's case fulfilled the foregoing requirements. A specimen of it was presented before a meeting of the Society of Gynecological Pathologists of New York.

Thomas sees no reason why implantation in an endometrial deposit in the uterosacral ligament, peritoneum covering the rectum or sigmoid, or any part of the pelvic cavity for

that matter, should not be accepted as the explanation of primary abdominal pregnancy. Gardner and Middlebrook believe that "primary abdominal pregnancy" describes any abdominal pregnancy in which evidences of origin from a primary intra-uterine or intra-tubal position are absent, and when the ovary is not definitely involved in the placental site.

In my opinion, primary abdominal gestation is likely to occur more often in cases of endometriosis. It is in these endometrial nests that the ovum finds a favorable nidus for its development. In two of my cases of abdominal pregnancy endometrial areas were present in the abdominal cavity. (Cases VII and IX.)

Curtis states that primary abdominal pregnancy may not be so rare as it was formerly thought to be; evidently the increased incidence of pelvic endometriosis has brought with it a corresponding increase in the incidence of primary pregnancy in the abdominal cavity.

Most abdominal gestations are secondary implantations. In these cases the placenta is drawn through the tubal perforation caused by rupture and continues its development on the peritoneal surface. Very infrequently these cases progress to term. If they approach or reach term, they are sometimes complicated by eclampsia, the symptoms of which are the same as those which occur during intra-uterine gestation. In these cases immediate abdominal delivery is indicated. (Figs. 36 to 44, Case IX.)

Some ectopic gestations present such mild symptoms at the time of rupture that the woman does not seek medical aid but makes a spontaneous recovery. Occasionally hyalinized villi (Figs. 17 and 18, Case V) observed in the tube at examination at a later date confirm the earlier existence of such a gestation.

Mummification and lithopedion formations are the result of unrecognized tubal ruptures which progressed to an advanced stage. In our experience twin ectopic pregnancies are infrequent. There was one case in this series in which the left tube contained two embryos in separate sacs.

Cervical Gestation. In this rare type of nidation the fertilized ovum traverses the uterine cavity and enters the cervical canal, instead of implanting in the upper portion of the uterus. (Fig. 14.) Although there is no reason to believe that the cervical mucosa possesses properties of resistance to the erosion and destruction of the trophoblast, this

mueosa is not especially well adapted to nourish the ovum.

Studdiford presents statistics from the literature for two groups of cases, each group containing fourteen cases. In the first group the occurrence of cervical pregnancy is sub-stantiated by pathologic examination; in the second, by "more or less well defined" clinical evidence. He states that cervical implantation is very rare and presents serious problems which sometimes terminate fatally. He calls attention to the criteria for cervical pregnancy set up by I. C. Rubin in 1911, which are as follows: (1) There must be cervical glands opposite the placental attachment; (2) this attachment of placenta to cervix must be intimate; (3) the whole or a portion of the placenta must be situated either below the entrance of the uterine vessels or below the peritoneal reflection of the anterior and pos-terior surfaces of the uterus; (4) fetal elements must not be present in the corpus uteri.

Combined extra-uterine and intra-uterine gesta-tion follows a serious clinical course. The uterine sac may abort before or after termina-tion of the eetopie gestation. Or the ectopic gestation may be removed surgically, leaving the intra-uterine one to develop to term. If the ectopie fetus is not disturbed and develops to term, it may be delivered along with the intra-uterine child. The eetopic gestation seldom interferes with passage of the intra-uterine fetus (DeLee and Greenhill, 1943).

In these combined gestations intra-uterine pregnancy may take place in the presence of a dead ectopic fetus; a living ectopic gestation may precede or follow the uterine implantation; or there may be simultaneous intra-uterine and extra-uterine conception.

Since Novak (1926) reviewed 276 cases of combined intra-uterine and extra-uterine preg-nancy, many additional cases have been reported in the literature.

An outstanding contribution to this subject was made by Samuel J. King, who subdivided coexisting intra-uterine and extra-uterine preg-nancies into two groups: (1) combined or simultaneous and (2) compound.

Combined Type. As has already been men-tioned in the historical section of this work, the first reported case of intra-uterine and extra-uterine pregnancy was that of Duverney in 1708. According to Novak (1926) combined pregnancy is a type of twin gestation.

Compound Type. This form is the super-imposition of an intra-uterine pregnancy upon a pre-existing ectopic gestation.

Included in my series is the case already reported by Mayer and Berson, in which there was a coincidence of a lithopedion associated with a normal intra-uterine pregnancy and subsequent ruptured extra-uterine gestation. At the time of the tubal rupture the abdominal calcified pregnancy was discovered free in the abdominal cavity, adherent to the omentum. No evidence of a placenta could be found. The other tube was entirely normal.

Changes in the Uterus during Ectopic Gesta-tion. Hyperemia and thickening of the en-dometrium result in an increase in the size of the uterus to that of a two to three months' intra-uterine gestation (Torpin, 1944). The organ assumes a slightly more globular shape and its consistency becomes softer (Kerr).

Regardless of the location of the gestation, the uterus responds by decidual reaction to the hormonal stimulation established by the preg-nant state. Some little time elapses before a perfectly formed uterine decidua develops; hence, in the rare cases of ectopie gestation which terminate in the first few weeks a com-pletely developed uterine decidua may not exist. As long as the ovum lives, uterine deeidual reaction continues. When embryonic death takes place the uterine decidua de-generates and some days later is sloughed off, sometimes as a uterine cast but more often in shreds. This process is accompanied by uterine contractions. When a whole decidual cast or a large decidual shred is passed, either patient or physician, or both, may mistake the occurrence for an intra-uterine abortion. Coin-cidental with uterine decidual degeneration the patient notices hemorrhagic vaginal discharge, which is almost invariably of uterine origin, although it may be caused by other conditions, one of which is an active interstitial gestation (Novak, 1944). Occasionally before the ovum dies there is slight vaginal bleeding of tubal origin, probably caused, as Novak suggests, by "ovular unrest" at the implantation site.

If ectopic and early intra-uterine preg-nancies are present simultaneously and if a diagnostic curettage is performed and chorionic villi are found, it is possible to overlook the ectopic component. In the later course of events the ectopic gestation is likely to become evident.

RECURRENT ECTOPIC GESTATION

There were three recurrent ectopic pregnancies in this series (1.73 per cent).

In ten series totaling 1,321 cases reported between 1939 and 1947, there were seventy cases of recurrence (5.3 per cent). The series represented were those of Atlee, Langman and Goldblatt, Lee, MacFarlane and Sparling, Marchetti et al., H. E. Miller, Nucci, Siegler, Ware and Winn (1946) and Woodhouse.

According to DeLee and Greenhill (1947) recurrent ectopic gestation occurs in about 4 per cent of cases of ectopic pregnancy.

A normal uterine pregnancy sometimes intervenes between two ectopic pregnancies. This occurred in seven of Urdan's twenty-seven cases of recurrent ectopic pregnancy.

Since etiologic factors responsible for ectopic pregnancy are frequently present in both tubes, it is not rare for the condition to occur in the remaining tube after the first tube has been excised. Occasionally the opposite tube, which was healthy at the time of the first ectopic pregnancy, may become diseased through infection resulting from laparotomy. Kerr reports a recurrent ectopic pregnancy in a tube which had been left *in situ* after conservative treatment for removal of the gestation.

Proponents of concomitant surgical procedures routinely correct incidental pelvic lesions in order to prevent ectopic gestation. In the series of sixty-five cases reported by Schauffler and Wynia, there was no instance in which a second ectopic pregnancy occurred; this was attributed to the fact that so many of their patients were sterilized.

Second and final part of this article will appear in our April 1949 issue.

SURGICAL PROBLEMS OF RETAINED INTRATHORACIC FOREIGN BODIES

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DURING World War II considerable experience developed in the treatment of thoracic wounds. The able work of surgeons placed close to the front lines permitted many men who were wounded in the thorax to reach general hospitals. In the European Theater of Operations of the United States Army patients requiring thoracic operations were transferred to centers located in general hospitals. Harken[4] has discussed the work of such a center in England. The data upon which this paper is based regard 187 patients operated upon for thoracic foreign bodies following war wounds. Thirty-five of the missles had lodged in the parietes. One hundred sixty-five cases were found among 511 patients admitted to a thoracic center in England* and the remaining twenty-two were treated in a nearby hospital.

In any discussion of the late removal of intrathoracic foreign bodies there arises the question of the advisability of operation for asymptomatic missiles. The general policy of surgeons working in field and evacuation hospitals was to remove large and readily accessible foreign bodies when thoracic wounds were débrided and closed. Thoracotomy was directly primarily to control of hemorrhage and closure of open wounds. There can be no question as to the desirability of removing foreign bodies lying close to important structures within the thorax. Furthermore, it is certainly wise to remove foreign bodies present when operations for clotted hemothorax and empyema are performed. Sommer and Mills[9] have shown that a large proportion of patients with empyema and infected hemothorax treated in this center had intrapleural foreign bodies.

*140th General Hospital.

Thomas[10] found a number of late complications among British veterans of World War I due to retained foreign bodies. The common symptoms, which arose ten to twenty years after injury, were hemoptysis, pain and purulent expectoration. The intrapulmonary missiles had caused bronchiectasis and lung abscess demanding operative treatment. Kay and Meade[7] mention two instances of gross hemoptysis caused by foreign bodies in the lung occurring six months and a year after injury.

CASE I. A Luxemburg resident about 30 years of age was admitted to an American general hospital because of severe pulmonary infection. He had sustained severe penetrating wounds of the right thorax during 1943 while serving with the German army in the Crimea. An empyema which followed had been treated by a rather extensive open thoracoplasty during 1944. The patient when examined in August, 1945, was seen to be a well nourished white man with a severe productive cough and the general signs of infection. Pus was draining from a small sinus track in the center of the thoracoplasty scar. Roentgenograms demonstrated a marked pneumonitis about a good sized intrapulmonary metallic foreign body. Penicillin therapy which had been started was continued. The acute exacerbation subsided. New films (Fig. 1) showed a ragged foreign body lying in an abscess cavity at the level of the partially resected seventh and eighth ribs. The lateral film demonstrated the abscess to lie posteriorly and the smaller foreign body to be in the parietes. At operation with local anesthesia September 18th the sinus track was unroofed laterally and found to drain a small empyema pocket. The stumps of the seventh and eighth ribs were then resected. The smooth walled abscess cavity was opened and the foreign body removed. The empyema and abscess, which communicated with a good-sized bronchus, were packed.

Case 1 illustrates the formation of a chronic abscess about a retained foreign body coexistant with an independent empyema. The abscess had either been present from shortly after the primary injury or had developed rather earlier than those seen by Thomas.[10]

TABLE 1

RESULTS OF CULTURES FROM FOREIGN BODY SITES

	Culture Positive	Culture Negative	Penicillin-Sensitive	Penicillin-Insensitive	Clostridia
Pulmonary......	23	22	7	1	7
Pleural.........	9	6	3	3	3
Mediastinal.....	5	2	1	1	1
Subphrenic.....	3	1	1	..	1
Parietal........	2	3	1	..	1
Total.........	42	34	13	5	13

Harken[4] states that pathogenic micro-organisms may be cultured from the sites of about 85 per cent of intrathoracic foreign bodies. Table 1 presents the data regarding cultures from foreign body sites in the cases under consideration. In this group cultures were planted from swabs rubbed in the foreign body sites of seventy-six cases. Cases in which infected hemo-thorax or empyema were present are not included in these figures regarding cultures which are from patients without pleural infection. Organisms were grown from forty-two (55.2 per cent). Penicillin-sensitive bacteria were found thirteen times in eighteen tested. Clostridial organisms were found thirteen times with nine instances of Clostridium Welchii. It is probable that a higher percentage of positive cultures could have been attained by placing the foreign bodies in culture media. The presence of pathogenic organisms at the site of asymptomatic foreign bodies furnishes a reason for their removal. A further reason for the removal of foreign bodies is the often unrecognized presence of clothing and rib fragments. In seven instances clothing was found with intra-

FIG. 1. Case 1. Film showing ragged foreign body lying in a pulmonary abscess.

pulmonary foreign bodies and in two with intrapleural foreign bodies. Rib fragments were associated with two each, intra-pulmonary and intrapleural foreign bodies. These additional non-metallic elements form a distinct hazard and were factors in pleural infection (Sommer and Mills[9]).

In summary, the indications for removal of foreign bodies were essentially those stated by Harken.[4] Foreign bodies causing pain, hemoptysis or expectoration and asymptomatic foreign bodies 1 cm. or more in diameter in two dimensions were removed. Definite indications were afforded by proximity of foreign bodies to the heart, great vessels or esophagus. Any missiles present were removed during operations for clotted hemothorax and empyema.

Important considerations in the elective removal of intrathoracic foreign bodies are the associated mortality and morbidity rates. Holman[5] made the first American report in World War II of the removal of five foreign bodies without incident. In Table II are given data regarding foreign bodies removed from the thorax by a number of surgeons who were working in British and American thoracic centers some distance from the front. The patients treated were probably generally of the

same type as those discussed in this article. There were five deaths (0.9 per cent) in 565 cases.

Data regarding morbidity following foreign body removal are harder to obtain. Harken[4] reported two empyemas follow-

tions. On one occasion 30,000 units of penicillin were injected after aspiration. Friedländer's bacillus was cultured from the pus of the empyema.

In the early work of the center postoperative intercostal drainage was seldom

TABLE II

MORTALITY IN OPERATIONS FOR LATE REMOVAL OF INTRATHORACIC FOREIGN BODIES

Authors	No. of Operations	Deaths	Mortality Rate (Per cent)
D'Abreu, Litchfield and Hudson[1]	49	2	4.1
Blades and Dugan[2]	16	0	
Harken[4]	247	1	.4
Holman[5]	5	0	
Johnson[6]	23	0	
Kay and Meade[7]	23	0	
Tuttle, Langston and Crowley[12]	44	0	
Sommer and McColloch	158*	2	1.2
	565	5	.9

* Figure excludes parietal foreign bodies with local removal.

TABLE III

TYPES OF OPERATIONS

Operation	Location of Foreign Body				
	Pulmonary	Pleural	Mediastinal	Subphrenic	Parietal
Thoracotomy	58	12	19	4	3
Limited thoracotomy	4	8	1	1	
Decortication for clotted hemothorax	8	9	..	1	3
Empyema					
Open drainage	3	7	..	1	
Decortication	5	5			
Limited rib resection and packing	..	2			
Local excision	..	..	..	2	29
Open drainage, subphrenic and liver abscess	..	..	..	2	
Total	78	43	20	11	35

ing more than 200 thoracotomies for foreign bodies. Table III lists the operations performed in the center for foreign bodies in various locations. One hundred thirty-one thoracotomies were carried out in the absence of pleural infection. These included twenty-one decortications for clotted hemothorax; two empyemas followed (1.5 per cent). One came after a decortication for clotted hemothorax with removal of an intrapleural foreign body. Two rib resections were necessary to cure the pocketed empyema. A second small empyema followed the removal of two intrapulmonary foreign bodies, the larger of which lay in a small abscess. A non-hemolytic Staphylococcus aureus sensitive to penicillin was grown from the abscess. Two intercostal drainage tubes were used for two days after operation; 360,000 units of penicillin were given intramuscularly in the first three postoperative days. A small empyema developed which was cured by two aspira-

used following thoracotomy for a foreign body. In thirty-two instances penicillin was placed in the pleural cavity prior to closure. The customary amount was 30,000 units although 40,000 and 100,000 units were used on a few occasions. No empyemas developed in this group. Intercostal drainage was used more frequently as the work progressed and always following decortication. Intramuscular penicillin administration was used only four times other than after decortication for empyema. Sulfonamide drugs were used on only two occasions. The two empyemas developed in drained cases. It was believed that good surgical technic and prompt expansion of the lung, however, were more important than antibiotic drugs in the prevention of postoperative pleural infections.

One other serious complication occurred that has been discussed by Sommer and Mills.[9] A ragged foreign body was removed from the apical segment of the lower lobe of a patient at the time of decortication for a small clotted hemothorax. The

TABLE IV
TYPES OF MISSILES

	Location of Foreign Body				
	Pulmonary	Pleural	Mediastinal	Subphrenic	Parietal
Bullet	7	2	7	1	5
Shell fragment	70	41	13	10	30
Needle	1				
Total	78	43	20	11	35

foreign body lay adjacent to a good sized vein which was retracted during its exposure. A pulmonary abscess developed in the affected lung segment which regressed completely with penicillin and sulfadiazine therapy. Some days later convulsions occurred. Two exploratory operations at a neurosurgical center failed to locate the suspected brain abscess. When last seen, the patient was in a serious condition and further follow-up information is not available.

Table IV presents the types of foreign bodies present in the patients who underwent operation. As is usual shell fragments were predominant. An ordinary straight pin was removed from the apical segment of the lower lobe of one patient who was unable to give any explanation as to how the pin had reached the pulmonary parenchyma. Two patients had double intrapulmonary missiles and two had foreign bodies in both the lung and pleura.

Prior to operation efforts were made to localize correctly foreign bodies. Posteroanterior and lateral roentgenograms were made in every case. Many patients were fluoroscoped. In certain cases fluoroscopic and roentgenographic studies of the esophagus with barium meal were very helpful in correct localization.

The operations performed are listed in Table III. The usual procedure was thoracotomy with posterolateral resection of a sufficient length of a rib to permit good exposure of the intrathoracic contents. The incision of Crafoord[3] was found to be very helpful for foreign bodies high in the chest. Whenever the position of the foreign body made use of an anterior approach advisable, intercostal incisions were used. Small incisions, termed limited thoracotomy, were used rather infrequently. Although this method was used with great success by Touroff[11] and others, the greater advantage seemed to lie with . larger exposure. Twenty-one foreign bodies were removed at the time of decortication for clotted hemothorax. The foreign bodies associated with empyema were usually removed at the time of drainage or decortication, but in two cases second operations were necessary to remove the missiles. The great majority of parietal foreign bodies were removed through a small incision with local anesthesia.

It is generally recognized that thoracic surgery cannot succeed without well administered anesthesia. The work of the center was made possible by Major Lawrence J. Schuhmacher, Jr., M.C., chief of the anesthesia section, who developed a staff to carry on the duties of this section. Endotracheal ether anesthesia was used for all open thoracotomies. Furthermore, endotracheal anesthesia should be used whenever there is a possibility that a parietal foreign body may lie within the pleural cavity. On one occasion an attempt was made to remove an intrapleural foreign body with local anesthesia since it was thought to lie in the parietes. The operation was unsuccessful due to open pneumothorax. At a second operation with endotracheal anesthesia the foreign body was readily extracted. Local and intravenous anesthesia were used on a number of occasions.

Every effort was made prior to operation

to have the patients in good condition. Patients with empyema were operated upon promptly. Blood transfusions were used preoperatively whenever necessary to correct anemia. After one narrow escape from a tragedy an intravenous infusion was always begun during induction of anesthesia and blood was ready for transfusion if necessary.

The postoperative care was managed according to well known principles. Adequate fluid intake was maintained. Although provision for oxygen therapy was constantly available, it was used only rarely. Atelectasis occurred several times and was treated with bronchial catheter suction and bronchoscopy. The arrangement of the center permitted the grouping of postoperative and seriously ill patients on one ward. Continuity of nursing personnel insured efficient care.

Any discussion of thoracic injuries and operations should include rehabilitation. Early postoperative ambulation is an important factor. The patients were customarily out of bed within forty-eight hours. Voluntary respiratory exercises were begun on admission to the center and continued after operation. These exercises restored normal function of the injured and operated sides of the thorax. The patients were very cooperative in their efforts to gain unilateral control of respiration. The art of voluntary respiratory exercises has been well described by Miss Reed[8] and Harken[4] has emphasized their importance. Only a few of these patients were returned to duty in the theater due to evacuation policies. They did return to the United States, however, as walking patients with every prospect of living normal lives. Under other circumstances more men could readily have been used in the theater.

PULMONARY FOREIGN BODIES

The largest single group of foreign bodies were those within the lung. Table III shows that of the seventy-eight pulmonary foreign bodies fifty-eight were

operated upon by the usual thoracotomy and four by limited thoracotomy. Decortication for clotted hemothorax was done in eight cases and in five for empyema along with foreign body removal. In three cases simple open drainage of empyemas was performed and the foreign bodies removed from the lungs. In one of these the foreign body was removed by a rib resection at a second operation. At the first operation for drainage the foreign body was not accessible and the patient was too ill for a prolonged procedure. In one case a prolonged search failed to locate a foreign body in the right hilar region. No deaths occurred. The complications were one embolism and one empyema. One patient was not operated upon for a large foreign body close to the arch of the aorta. The patient was admitted with a satisfactorily drained empyema which healed. He had had, however, three previous operations. A blood culture had been positive for Staphylococcus albus. Cerebral embolism had apparently occurred. The patient was in poor physical condition, was deaf and almost blind as the result of injury and disease.

CASE II. A twenty-one year old corporal sustained penetrating shell fragment wounds of the left thorax and shoulder April 6, 1945. The wounds were débrided and a plaster spica dressing was applied for the badly fractured left humerus on April 7th. Penicillin was given in an unknown amount. On April 21st secondary closures of the wounds of the arm and thorax were performed. Penicillin (520,000 units) was given intramuscularly during the following days. The patient was admitted April 30th. The left arm was in a hanging plaster dressing. An unhealed wound was present on the left shoulder. Roentgenograms (Fig. 2) demonstrated a large foreign body in the left lung posteriorly. On May 17th the left pleural cavity was opened after resection of the fifth rib. A ragged foreign body measuring 3.5 by 2.5 by 2 cm. was removed from the apex of the lower lobe. The opening in the lung was closed with a fine catgut suture. After irrigation of the pleural cavity with saline solution the thoracic wall was closed
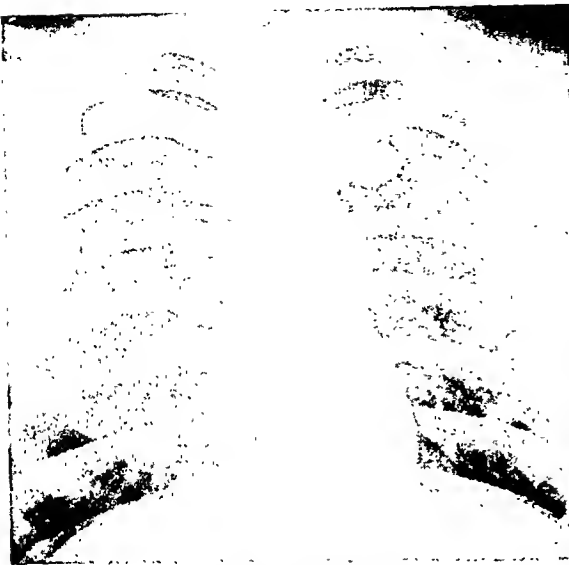
FIG. 2. Case II. Anteroposterior film showing large intrapulmonary foreign body.
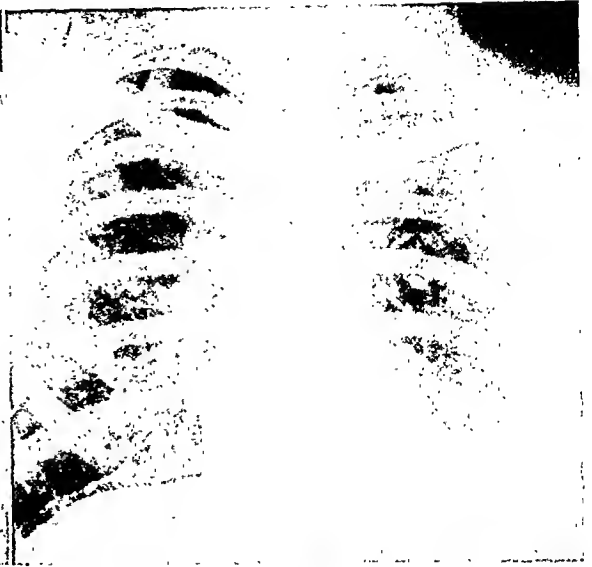
FIG. 3. Case II. Anteroposterior film three days following removal of foreign body from lung.

FIG. 4. Case III. Anteroposterior film showing foreign body in right upper lobe.
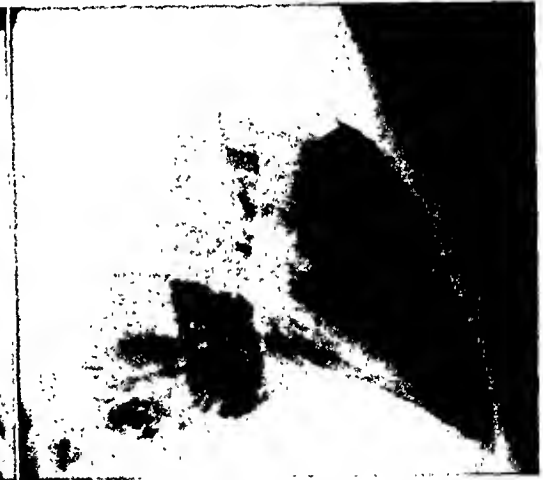
FIG. 5. Case III. Lateral film showing anterior position of foreign body.

with interrupted sutures. Clostridium Welchii and tetani and coagulase and mannite positive Staph. aureus were cultured from the foreign body site. The Cl. Welchii was sensitive to penicillin. The patient made an uneventful recovery from the operation. Fluid was aspirated from the pleural cavity on several occasions. Roentgenograms (Fig. 3) showed complete re-expansion of the lung on May 20th. The soldier was transferred to the United States as ambulatory on June 1st.

CASE III. A twenty-six year old soldier sustained a penetrating shell fragment wound of the right axilla February 10, 1945. The wound was débrided the same day. Penicillin (1,000,000 units) was given intramuscularly February 10th to the 15th; 500 cc. of fluid were aspirated from the right pleural cavity February 13th and 40,000 units of penicillin were injected. He was admitted March 4th. Roentgenograms on March 5th (Figs. 4 and 5) demonstrated a rectangular foreign body lying anteriorly in the upper lobe of the right lung. On March 13th a thoracotomy was performed with an anterior incision through the second interspace. The internal mammary vessels were doubly ligated and divided. The loosely adherent lung was freed and the foreign body removed from the lung beneath the first interspace. The thoracic wall was then closed in layers with interrupted sutures after the pulmonary wound had been closed with a fine

FIG. 6. Case III. The patient following operation.

catgut suture. The patient (Fig. 6) made an uneventful recovery. He was transferred to the United States April 13th as ambulatory.

CASE IV. A twenty-one year old soldier sustained a perforating shell fragment wound of the left arm with a severe compound fracture of the humerus and a penetrating wound of the left thorax March 4, 1945. On this same day the arm wound was débrided and the humerus fixed with a plaster dressing; thoracotomy was performed through the bed of the resected seventh rib. Penicillin (860,000 units) was given intramuscularly from March 4th to the 11th; 700,000 units March 16th to 22nd and 720,000 units from April 9th to the 15th. The arm wound was dressed several times. On five occasions 20 to 400 cc. of fluid were aspirated from the left pleural cavity. The patient was admitted on May 2nd. Roentgenograms (Figs. 7 and 8) demonstrated a left pleural effusion with a large air pocket superiorly; the heart was drawn to the left and a large foreign body lay apparently in the lower lobe. Pus, 50 cc., and some air were aspirated May 15th. Cl. Welchii and a mannite and coagulase positive hemolytic Staph. aureus, which was sensitive to penicillin, grew from the pus. On May 21st a left thoracotomy was performed with further resection of the seventh rib. The lung was compressed against the mediastinum and the

pleural cavity was filled with pus and large necrotic clots. The pulmonary lobes, which were greatly distorted, were freed with difficulty from the tough fibrous scar over the visceral pleura. The dissection to liberate the lung was carried out in part within the plain of the visceral pleura, but the lung was completely mobilized. The flat, metallic, foreign body, which measured 2.5 by 1.8 by 0.3 cm., was removed from the lower lobe. It was covered with cloth. The pleural cavity was drained with anterior, lateral and posterior intercostal tubes with water seals. The thoracic wall was closed in layers. Penicillin (960,000 units) was given intramuscularly from May 21st to the 26th; 160,000 units of penicillin were used for irrigation of the drainage tubes which were removed the 25th and 26th of May. The patient made a very satisfactory recovery with primary healing of the empyema. Roentgenographic examination on June 5th (Fig. 9) demonstrated the lung to be fully expanded. The patient (Fig. 10) was transferred to the United States in an ambulatory status on July 18th.

Cases II, III and IV illustrate the principal problems and methods of removal of foreign bodies in the lung in the center. In Case II the usual thoracotomy was performed while limited thoracotomy was used in Case III. Thoracotomy with decortication of the lung with removal of the intrapulmonary foreign body was certainly the proper procedure in Case IV in the presence of empyema with a markedly compressed and distorted lung.

In two instances pulmonary abscesses were present about foreign bodies. The course of one case, which was complicated by the only empyema following removal of an intrapulmonary foreign body, has been described. The second abscess presented an interesting problem.

CASE V. A twenty-four year old soldier sustained a perforating shell fragment wound of the left arm and a penetrating wound of the left thorax, with fracture of the third rib on March 13, 1945. A severe compound fracture of the right femur was caused by another fragment. The wounds were débrided the same day and a plaster spica dressing applied to fix the
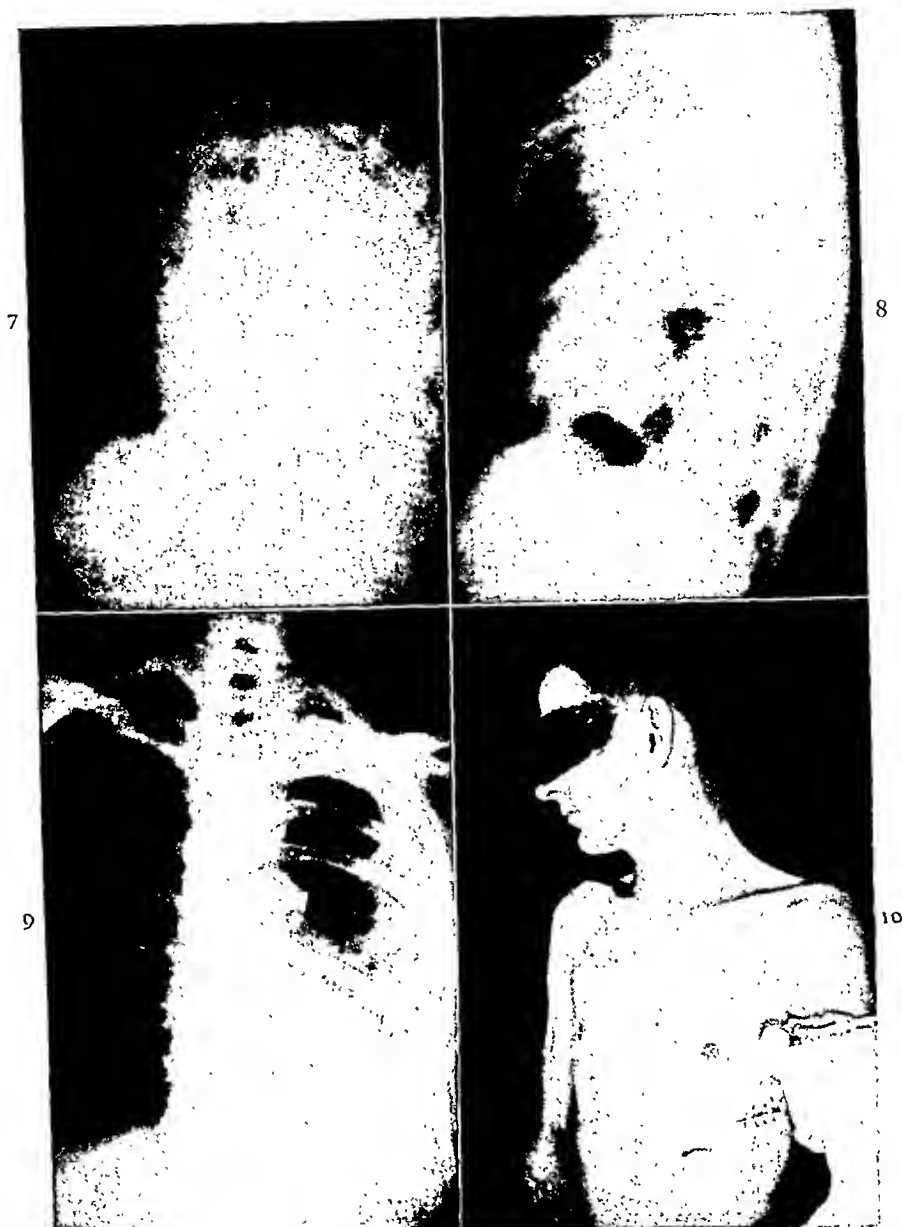
FIG. 7 Case IV. Postero-anterior film showing empyema with fluid level and heart displaced to left with large foreign body.
FIG. 8. Case IV. Lateral film of empyema and intrapulmonary foreign body.
FIG. 9. Case IV. Postero-anterior film fifteen days following decortication for empyema and removal of foreign body from lung.
FIG. 10. Case IV. The patient fifteen days following decortication and removal of foreign body.

right leg. Penicillin (2,300,000 units) was given intramuscularly from March 13th to April 3rd. Severe hemoptyses occurred from April 1st to the 3rd. The patient was admitted April 3rd with continuing hemoptysis. The right leg was in a Thomas splint. The most satisfactory roentgenogram of the thorax had been taken in bed in an oblique projection. It showed the large foreign body lying posteriorly in a large upper lobe abscess cavity. Prompt operation was advisable to prevent recurrent hemoptysis. On April 4th the patient was carefully placed upon the right side after induction of anesthesia and passage of an endotracheal tube. The left pleura was opened with resection of a long length of the fifth rib. The lung was densely adherent beneath this rib to the pleura which had been opened carefully posteriorly. Pus, which
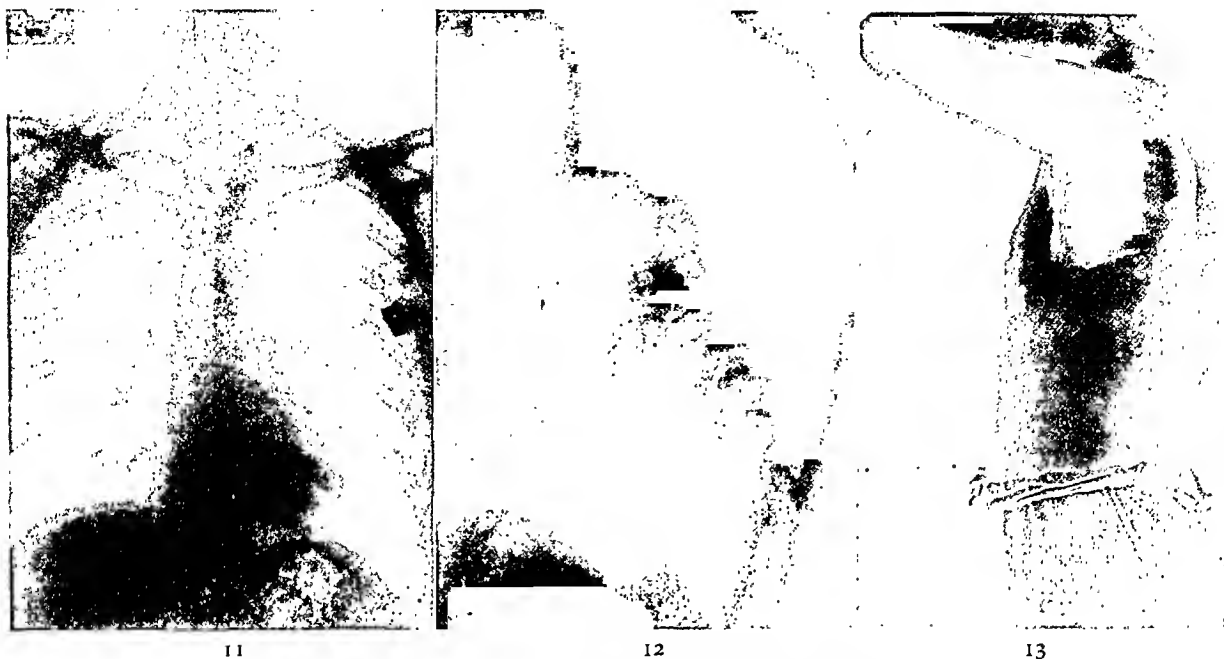
Fig. 11. Case vi. Postero-anterior film showing foreign body in left pleural cavity.
Fig. 12. Case vi. Lateral film showing foreign body with marked adjacent pulmonary reaction.
Fig. 13. Case vi. Patient forty-two days after operation; the posterior wound of entry and axillary wound of foreign body removal are seen.

was seen coming from a small opening in the lung, was quickly aspirated. The opening was enlarged and a large ragged foreign body and considerable pus were removed from the abscess. The lung was closed with a fine catgut suture. The lung was adherent below the fifth rib but was free above it. An intercostal drainage tube with water seal was inserted through the third interspace posteriorly. Gloves and instruments were changed before closure of the thoracic wall in layers. The convalescence was uneventful. The drainage tube was removed with the lung fully expanded on the third postoperative day. Penicillin was not given. A penicillin-sensitive Cl. Welchii and Streptococcus viridans were grown in cultures from the pus. The patient was sent to the United States after further appropriate treatment for the fractured femur.

It probably can be correctly argued that the patient in Case v should have been treated with resection of a short length of rib and packing of the pulmonary abscess. It does show that this type of abscess may heal with removal of the offending foreign body. Furthermore slight soiling of the pleura did not cause empyema with prompt re-expansion of the lung.

INTRAPLEURAL FOREIGN BODIES

The second largest group of foreign bodies are those lying intrapleurally. Of the forty-three intrapleural foreign bodies twelve (27.9 per cent) were associated with empyema. Limited thoracotomy was employed relatively more frequently for intrapleural than for intrapulmonary foreign bodies. (Table iii.) Twelve routine thoracotomies were performed and eight limited. One advantage of the larger operation was demonstrated by the unexpected discovery of omentum herniated through a lacerated diaphragm; this discovery would not have been made with the use of a small incision directly over the foreign body. The ample incision permitted ready repair of the hernia. Decortication for clotted hemothorax and empyema were performed eight and nine times, respectively, along with foreign body removal from the pleura. In four cases empyemas were drained and foreign bodies removed. In one case a second operation was performed thirteen days after drainage of an empyema and a large foreign body inaccessible at the drainage procedure removed; the wound was

closed and healed primarily. In two cases foreign bodies were removed and the wounds packed lightly and permitted to close by granulation. There were no deaths in this group and one postoperative empyema.

CASE VI. A soldier sustained a penetrating shell fragment wound of the left thorax posteriorly March 20, 1945. The same day the wound was débrided. Penicillin (180,000 units) was administered intramuscularly from March 20th to the 23rd. The soldier was admitted on April 6th. Roentgenograms (Figs. 11, 12) demonstrated a flat, metallic foreign body lying in the periphery of the left thorax, with considerable surrounding soft tissue reaction. On April 10th with endotracheal anesthesia a curved axillary incision was made. The fractured fourth rib was resected subperiosteally. A number of loose bone fragments were removed from the pleura and surrounding lung. After removal of the foreign body which lay on the lung a good sized bronchial fistula was seen. The wound was lightly packed. Prompt healing of the wound and fistula took place. The patient (Fig. 13) returned to the United States on May 23rd. No organisms were demonstrated from the foreign body site by smear or culture.

MEDIASTINAL FOREIGN BODIES

A very interesting group of foreign bodies are those in the mediastinum. In all, twenty-three were seen. In three instances operation was not performed. In two of these the foreign bodies lay behind the sternum; operation was deferred because of nearby granulating wounds following the resection of infected cartilages and ribs. In a third case a mediastinal foreign body was accompanied by an infected hemothorax which was fortunately cured by aspiration and penicillin therapy. The planned thoracotomy was given up because of two severe bouts of thrombophlebitis. In the first attack the vena cava and right femoral veins were involved and in the second the left subclavian. It did not seem wise to operate upon a patient with such a recent history. Twenty thoracotomies were performed, one of

FIG. 14. Case VII. Anterioposterior film showing bullet in right ventricle.

which was limited. One postoperative death occurred and no empyemas.

The mediastinal foreign bodies are associated with important structures. Seven lay on or were embedded in the pericardium; all were removed without difficulty. There were five cardiac foreign bodies, four within the chambers and one deep in the muscle of the left ventricle. All were operated upon and three removed. In one case the foreign body in the right ventricle was not adequately exposed through an anterior incision and was left untouched. In a second case the foreign body in the left auricle could not be felt and it was thought best not to open the auricle. A very interesting symptom in a patient with a shell fragment lying on the diaphragmatic aspect of the right ventricle was severe pain referred to the left shoulder entirely relieved by removal of the foreign body.

CASE VII. A twenty-two year old soldier sustained a compound fracture of the right humerus and a penetrating bullet wound of the right thorax March 30, 1945. The wounds

FIG. 15. Case VII. Lateral film showing bullet in right ventricle with haziness due to cardiac movement.

FIG. 16. Case VII. The patient twenty-two days after removal of bullet from right ventricle.

were promptly débrided and the fracture was immobilized with a plaster spica dressing. Penicillin (720,000 units) was given intramuscularly from March 30th to April 3rd. The wounds were closed secondarily April 10th with re-application of the plaster spica dressing. The patient was admitted April 23rd. Roentgenograms (Figs. 14, 15) demonstrated the bullet lying in the right ventricle above the diaphragm. The movement of the foreign body is seen well in the lateral projection. Electrocardiagrams showed evidence of right myocardial damage. It seemed likely that the bullet had reached the ventricle through the blood stream. On April 30th the left pleural cavity was opened by an incision through the fifth anterior interspace. The internal mammary vessels were doubly ligated before division. The fifth and sixth costal cartilages were divided. The pericardium was opened. The bullet could be palpated lying against the diaphragmatic portion of the right ventricular wall. Two silk stay sutures were placed anterior to the bullet but only one could be placed posteriorly because of the proximity of the right coronary vessels. An incision was made with a knife parallel to the adjacent vessels. The bullet was reached, grasped with a curved hemostat and withdrawn. The stay sutures,

which had been held by an assistant, were crossed. Only a few cc. of blood were lost probably due to endocardial clots. Interrupted silk sutures were employed to close the myocardial incision. A free graft of pericardium was fixed over the incision by tying the stay sutures to each other. The pericardium was closed with fine silk sutures leaving an opening for drainage. The thoracic wall was closed without drainage. The postoperative course was without event. Sanguineous fluid was aspirated from the pleural cavity on three occasions. The patient (Fig. 16) was ambulatory and returned to the United States on May 27th.

The remaining eight mediastinal foreign bodies were closely associated with the esophagus and great vessels. In two instances operations were unsuccessful in removing foreign bodies. In one case the well encapsulated shell fragment lay on the vertebrae. The incision had not been well placed. This fragment was removed after return of the patient to the United States. In a second case a bullet was approached through the left pleural cavity. It was found lying to the right of an
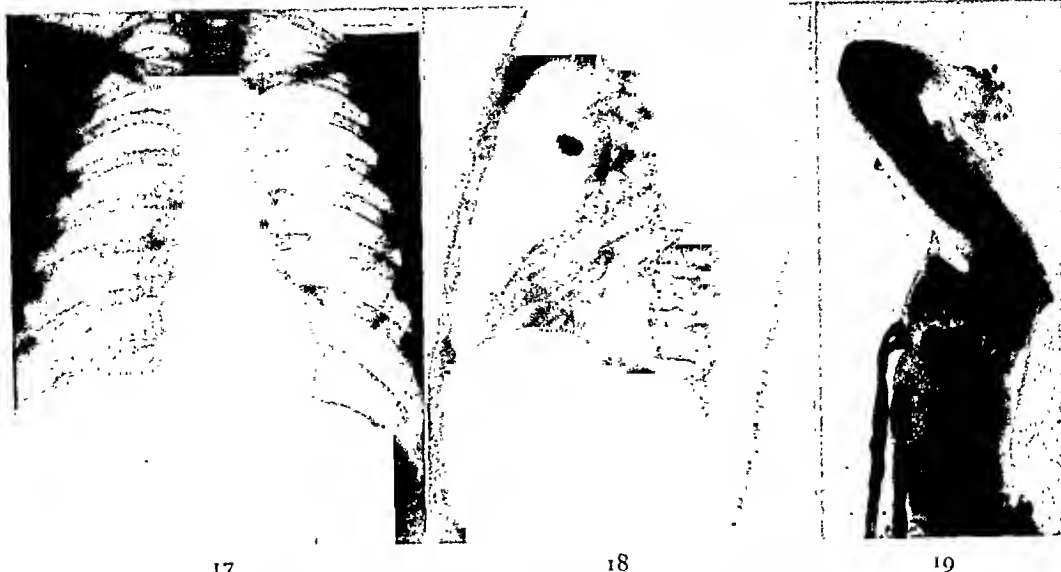
FIG. 17. Case VIII. Postero-anterior film showing bullet in mediastinum.
FIG. 18. Case VIII. Lateral film showing bullet lying in anterior mediastinum.
FIG. 19. Case VIII. The patient five days after removal of bullet from mediastinum.

aneurysmal dilatation of the aorta. Dissection over the damaged aorta did not seem wise.

CASE VIII. An eighteen year old soldier sustained a penetrating bullet wound of the right thorax on April 8, 1945. The wound was débrided that day; 260,000 units of penicillin were given intramuscularly from April 8th to the 10th. He was admitted April 27th. Roentgenograms (Figs. 17, 18) showed the bullet lying in the superior mediastinum. On May 15th a left posterolateral transpleural approach was employed to remove the bullet. The Crafoord[3] incision, (Fig. 19) which was found so useful with foreign bodies located high within the thorax, was used to permit ready resection of the fifth rib. The bullet was removed from a pocket containing brown fluid anterior to the aorta after opening of the mediastinal pleura which was not closed. Penicillin, 100,000 units, in 100 cc. of saline solution were placed in the pleural cavity before closure of the thoracic wall without drainage. No organisms were seen in smears from the foreign body site. The patient, who was seen five days after operation returned to the United States on June 1st. (Fig. 19.)

CASE IX. A thirty-one year old soldier sustained a penetrating shell fragment wound of the upper anterior right thorax February 24, 1945. The wound was débrided the following day. 300,000 units of penicillin were given

intramuscularly from February 25th to the 27th. Rather marked edema of the left cervical region and arm was present from March 2nd to March 6th, with a temperature elevation to 103°F. During this period 1,040,000 units of penicillin were administered. The patient was admitted on March 19th. He presented the general signs of infection with an elevated white blood count. Roentgenograms (Figs. 20, 21) showed a widening of the upper anterior mediastinum with a shell fragment lying posteriorly in the mediastinal shadow. A diagnosis of mediastinal abscess was made. On March 22nd a transverse cervical incision was made; exploration of the superior mediastinum failed to disclose an abscess. The left pleural cavity was entered through an anterior incision. A dense mass was found above the aortic arch bulging to the left. A thrill was noted. In attempting to dissect into the mass an opening was made into a false aneurysm. The tremendous hemorrhage was controlled with a finger. The sternum was transected to afford better exposure and a second opening was made into the aneurysm. The two openings were closed with silk sutures after removal of the shell fragment. The sternum was wired and the thoracic wall closed. During the operation 1,500 cc. of blood and 7 units of plasma were given. The patient died some hours later with an ascending temperature probably due to cerebral hypoxia during the operation. Postmortem examination disclosed a huge false
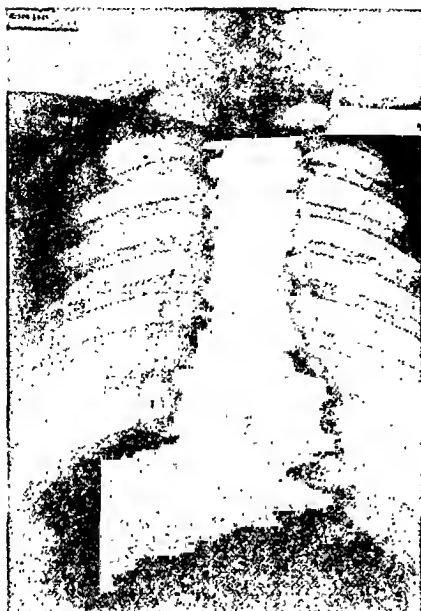
FIG. 20. Case IX. Postero-anterior film showing false aneurysm with shell fragment in upper mediastinum.

FIG. 21. Case IX. Lateral film of false aneurysm of anterior mediastinum with shell fragment.

aneurysm surrounding the great vessels and intimately associated with the arch of the aorta. The mediastinal pleura had apparently afforded substance to form the wall of the aneurysm. Close to the aorta there was a linear opening in the wall of the left subclavian artery which was the site of an extensive thrombus.

In Case IX the significance of the edema of the left arm had not been appreciated and a correct diagnosis had not been made. It is hard to see, however, how the condition could have been corrected since proximal control of the vessels could not have been obtained.

SUBPHRENIC FOREIGN BODIES

There were eleven subphrenic foreign bodies removed. Seven were removed transdiaphragmatically, four by thoracotomy, one each by limited thoracotomy at decortication and at combined drainage of an empyema and subphrenic abscess. Two small intercostal incisions sufficed to remove foreign bodies below the diaphragm. One was removed at the time of drainage of a liver abscess and another from a patient with a subphrenic abscess. No postoperative empyema occurred and

one patient died. The patient who died was admitted with a subphrenic abscess which was drained widely with rib resection. The large foreign body which lay lateral to the vertebral bodies could not be reached. Severe hemorrhages occurred thought to be coming from a stump of the splenic artery near the foreign body which was then removed through an abdominal incision. The left kidney was later removed when recurrent hemorrhage led to the correct diagnosis of wound of the renal artery. The patient died of peritonitis after several severe hemorrhages due to infection.

CASE X. A twenty year old sergeant sustained a penetrating shell fragment wound of the right thorax below the tip of the scapula January 13, 1945. The wound was débrided the same day. 500,000 units of penicillin was given intramuscularly from January 13th to the 16th. Sanguineous fluid, 2,500 cc., was aspirated from the right pleural cavity in four sittings, the last January 27th. The patient was admitted February 12th. Roentgenograms (Fig. 22) showed the foreign body lying beneath the heart. On February 15th the left pleural cavity was opened through an anterior intercostal incision. The pericardium was opened

FIG. 22. Case x. Postero-anterior film show-
ing foreign body below cardiac shadow and
diaphragm.

FIG. 23. Case x. The patient following
removal of subphrenic foreign body.

and the shell fragment felt beneath it. The
diaphragm was then split and dissection
carried forward beneath the pericardium until
the fragment was reached and removed. The
diaphragm was closed with fine silk sutures
and the pericardium was loosely approximated
in the same manner. The thoracic wall was
closed without drainage. Cl. pseudodiph-
thericum was cultured from the foreign body
site. The patient (Fig. 23) made an uneventful
recovery and returned to the United States
in an ambulatory status March 9th.

PARIETAL FOREIGN BODIES

There were thirty-five foreign bodies
removed from the thoracic wall. Three
were removed by thoracotomy and three
at the time of decortication for clotted
hemothorax. Twenty-nine were removed
through suitably placed soft part in-
cisions. Parietal foreign bodies may pre-
sent difficult problems of localization and
removal. It cannot be emphasized too
much that certain suspected parietal for-
eign bodies should be removed with
endotracheal anesthesia in order to avoid
re-operations and uncontrolled open pneu-
mothorax. There were no complications

of note following operations on those in
this group.

SUMMARY

A report has been made regarding
the operative treatment of 187 patients
with foreign bodies lodged in the chest.
Of these 162 were within the thorax and
thirty-five were in the parietes. The ex-
perience with these cases and data from
the literature indicate that intrathoracic
foreign bodies adjacent to important struc-
tures should be removed along with any
causing symptoms. Elective removal of
foreign bodies larger than 1 cm. in two
or more directions is advised. The operative
removal of intrathoracic foreign bodies
is attended by low mortality and morbidity
rates.

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In cases of pulmonary arteriovenous aneurysms congenital and mechanical defects are present between the arteries and veins in some portion of the lung field. Medical therapy is of no avail but lobectomy, or any other similar procedure which removes the involved lung area, is followed by a successful result in almost all cases. W. L. Watson reports two successful cases. In one a lobectomy was done; in the other he found, doubly ligated and severed, an aberrant artery springing from the thoracic aorta. With elimination of this artery, the lung disorder seemed to disappear. At any rate no mass was palpable, hence, no lung tissue resection was done. The patient did well. We are certainly making great strides in the fields of thoracic and vascular surgery. (*Richard A. Leonardo, M.D.*)

PERFORATED GASTRIC AND DUODENAL ULCERS*

AN ANALYSIS OF 200 CONSECUTIVE CASES

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ACUTE perforation of a gastric or duodenal ulcer is a frequent surgical emergency. In the more common diseases it is wise to review periodically the etiologic factors, methods of diagnosis and results of therapy and in view of such knowledge plan for the future. This report is an analysis of 200 consecutive cases of perforated ulcers of the stomach and duodenum seen at the University Hospital, Baltimore, from 1935 to 1946. These data include private patients as well as free patients and patients operated upon by senior surgical house officers and members of the visiting surgical staff. The patients came from every strata of society and are typical of the group of patients seen in a general hospital.

The history of this problem is quite interesting in that many of our present day problems were encountered shortly after surgery was first attempted in the treatment of perforation. One of the earliest accounts[13] of a perforated ulcer was made in 1670. A member of the royal family of France had a gastric ulcer which was proven by postmortem examination. Hamburger[16] in 1747 reported the first diagnosed case of perforated duodenal ulcer which was also proved by postmortem examination. O'Hara[15] in 1875, at a Philadelphia pathologic meeting, reported the first case in the United States. Mikulicz[14] first operated upon a perforated peptic ulcer in 1880, but the patient died in shock three hours later. Mikulicz did not report this case until 1897. The first successful operation was performed by Heussner[11] in 1892 with a simple closure by suture. Weir[19] had the first successful operation for perforation in the United States in 1896. In 1892 Hall[9] reported six cases of patients who underwent spontaneous cures of the perforation without surgery. Braun[4] in 1897 advocated the use of gastro-enterostomy with closure of the ulcer; in 1909 Dowden[7] advocated a longitudinal excision of the ulcer with a transverse suture of the excised area and finally in 1919 Von Haberer[18] advised gastric resection in perforated ulcer.

ETIOLOGIC FACTORS

Sex and Age of the Patient. In this series of cases there were 93.5 per cent males with perforated ulcer and 6.5 per cent females (Table 1) which corresponds with the reports of the majority of writers but is not as great a division as that of DeBakey[6] with 98.1 per cent and Davison[5] with 98 per cent males. There were no patients in the childhood group, the youngest being nineteen years of age and the oldest seventy-six years of age. Fifty-one and fifty-four patients were seen in the fourth and fifth decades, respectively, with perforated ulcer of the stomach or duodenum. Only 14 per cent of the patients were seen in the first three decades which is decidedly less than that in DeBakey's series of 25 per cent but more than the 8 per cent reported by Black and Blackford[2] at the Mayo Clinic. The relationship of age to mortality corresponds with that reported by Raw,[17] DeBakey and Black and Blackford, in that the mortality rate rises steadily as older patients come to this type of surgery. Raw reports a 7.6 per cent mortality rate in patients under forty-two, DeBakey reports 18.9 per cent mortality in the fourth decade and in this series the hospital mortality rate is 14.8 per cent for

patients under thirty years, 13.4 per cent for those between thirty and forty years and 36.5 per cent for all patients over the age of forty. However, twelve patients of this series were not operated upon so the mortality per age group for those operated

TABLE I

	No. Patients	Patients (Per cent)
Sex		
Males	187	93.5
Females	13	6.5
Race		
White	172	86.0
Negroes	28	14.0
Others	0	0
Age		
0–9	0	0
10–19	1	0.5
20–29	27	13.5
30–39	51	25.5
40–49	54	27.0
50–59	44	22.0
60–69	16	8.0
70–79	7	3.5
over 80	0	0

TABLE II

	No. Patients	Patients (Per cent)
January	12	6.0
February	12	6.0
March	19	9.5
April	16	8.0
May	19	9.5
June	26	13.0
July	11	5.5
August	8	4.0
September	25	12.5
October	25	12.5
November	10	5.0
December	17	8.5
Spring	54	27.0
Summer	45	22.5
Autumn	60	30.0
Winter	41	20.5

upon is 14.8 per cent for those under thirty, 11.5 per cent for those between thirty and forty and 18.8 per cent for those over the age of forty.

Race. The racial relationship cannot be definitely determined from this small series

in which only twenty-eight negroes were seen over a twelve-year period. (Table I.) This is probably due to the fact that relatively few beds are available for negroes in this hospital. DeBakey reports a racial incidence per 100,000 admission as being

TABLE III

	No. Patients	Patients (Per cent)
Hard labor	124	62.0
Professional	7	3.5
Sedentary (white collar)	48	24.0
No occupation	21	10.5

40.4 white and 36.4 negroes, thus revealing that acute perforations of gastric and duodenal ulcers occur about evenly in the two races.

Season and Occupation. There was no sharp demarcation in the seasonal incidence of this disease (Table II) which is contradictory to many early teachings and textbooks on surgery and medicine. The great majority of the patients (Table III) were classified as doing hard labor (corresponding well with the general population average). The absence in this series of the high-strung, nervous individual, who is so often characterized as the "ulcer type" as seen in the professional and sedentary (white collar) person, was interesting and again in contradistinction to earlier reports. These findings agree well with those of Anderson, Allen and Packard[1] in which they deny any seasonal or occupational relationship to the problem. Many series report the greatest incidence of perforation of gastric and duodenal ulcers occurring in the laboring class. Walton[20] reports 50 per cent, Fallis[8] reports 63 per cent, Zukschwerdt and Eck[21] report 69 per cent and Lang[12] reports 75 per cent of their patients with perforated gastric and duodenal ulcers to be in the laboring class.

History. Eighty-nine per cent of the patients had a history of gastric dis-

turbances, ranging from a mild feeling of fullness and discomfort after meals to a typical history of hunger pains, tarry stools and/or relief of pain with alkali. Thirty per cent of the patients had a positive history of use of alcohol during the episodes of gastric disturbance or just prior (a few days to two or three weeks) to the perforation. Sixteen per cent of the patients had just had a recent meal or had been drinking an alcoholic beverage within a few hours of the perforation. However, 11 per cent had the perforation occur without any history of gastric disturbances suggestive of the presence of a gastric or duodenal ulcer which is much lower than the 25 per cent reported by Bockus.[3] There was no history of trauma externally or internally such as a perforation occurring during a roentgenologic examination with barium meal. Interestingly enough, however, Fallis,[8] in an analysis of one hundred cases of perforated peptic ulcer at Henry Ford Hospital, reported a 4 per cent incidence of trauma related to perforation of the ulcer. Two of his patients had perforation occur immediately following external abdominal injury and two instances of perforation occurred during fluoroscopic examination of the stomach after ingestion of a barium meal.

DIAGNOSIS

The correct diagnosis of this catastrophe was made in 95.5 per cent of the cases. The usual diagnostic points mentioned in the records were a fairly definite history suggestive of a gastric or duodenal ulcer, with an exaggeration of symptoms for a day or two prior to perforation, sudden, sharp, knife-like epigastric pain, nausea and prostration. Confirming reports of some observers, vomiting was not seen as a constant finding as is stated by many standard surgical texts. In this case it was present in 45 per cent of the patients and then in the majority of instances the patient only vomited once and seldom more than two times. Hematemesis was

an unusual finding, occurring in only 7.5 per cent of the patients.

Examination usually revealed board-like rigidity of the abdomen, with extreme abdominal tenderness and muscle spasm, facies of agony and a reluctance to a change of position on the examining table. Early after perforation these signs were most marked in the upper abdomen but within a few hours usually the signs were those of diffuse peritonitis. The temperature and pulse rate were low but as peritonitis spread these tended to rise. Right lower quadrant pain, tenderness and rigidity were seen frequently when the spread of escaped fluid was down the right colic gutter. It was in this group of patients that the errors in diagnoses were made as acute appendicitis. If the patients were seen several hours after perforation, the signs were those of diffuse peritonitis but the diagnosis could usually be made on the history alone. Auscultation would reveal the characteristic quiet abdomen of peritonitis. The absence of liver dullness was not definite and was not commonly found. The presence of shock as defined by many present day laboratory determinations (hemoglobin, hematocrit, total protein, etc.) was not determined, but in seventy-two patients, or 36 per cent of cases, the admitting doctor stated that the patient was in shock. These patients were those seen soon after perforation and they were perspiring freely and their extremities were cool despite the fact that the blood pressure and pulse rate were usually within or near normal limits. The majority of those admitted thirty-six to forty-eight hours after perforation were prostrated and dangerously ill, presenting the clinical picture of generalized, late peritonitis. Laboratory examination usually revealed a leukocytosis of 13,000 to 18,000 if the patient was seen in the first eighteen hours after perforation, but this was not diagnostic or prognostic.

The patients' point of maximum tenderness was found in the epigastrium in 118 cases and in the right upper quadrant in

39 cases. Other recorded points of maximum tenderness were para-umbilical, right lower quadrant and left upper quadrant.

Roentgen examination of the patient in the upright position was performed in forty-eight cases. In twenty-nine cases,

TABLE IV

Anesthesia	No. Patients	No. Died	Died (Per cent)
General.............	66	14	21
Spinal..............	100	12	12
Local..............	2	0	0
Sodium pentothal....	3	0	0
Spinal—Sodium Pentothal.............	6	1	17
Spinal—general......	8	3	42
Avertin.............	3	0	0

or 60.4 per cent of those examined, it was positive for evidence of free air in the peritoneal cavity. This is a lower figure than that reported by Anderson, Allen and Packard[1] of 85.2 per cent and Klason[10] of 89 per cent. The nineteen patients in whom free air was not demonstrated in the peritoneal cavity by roentgenologic examination did receive surgery.

The most common mistaken diagnosis was acute appendicitis. This error was made in 3 per cent of the cases. DeBakey reports this error in his series, with percentages of 4.3 per cent and in other series from 5.6 to 20 per cent. This mistake was made in six patients and at operation a McBurney incision was made and was promptly closed for an upper abdominal incision when the true condition was found. Other mistaken diagnoses were cholecystitis with cholelithiasis (two cases) and coronary artery disease (one case).

SURGERY AND HOSPITAL COURSE

Of the 200 patients there were twelve who were not operated upon either because they refused surgery or the patient was moribund on admission. In three cases surgery was delayed for more than twelve hours after the hospital admission, two patients with almost a thirty-six-hour

delay. This was because one patient refused surgery early and in the other two patients the correct diagnosis was not made upon admission. Of the 188 cases seven methods of anesthesia were used. (Table IV.)

The method of approach to the upper portion of the peritoneal cavity was a right upper rectus (muscle splitting) in eighty-six cases, right upper paramedian in sixty cases, a transverse rectus in thirty-one cases and five cases each of left upper rectus and upper midline incisions. The ulcer site was classified as duodenal in 39.5 per cent, pyloric in 15 per cent and gastric in 45.5 per cent of the cases. This differs markedly from that reported by DeBakey as duodenal 51.2 per cent, pyloric 9.8 per cent and gastric 38.9 per cent, and Black and Blackford in ninety-six cases with eighty-seven duodenal (90.6 per cent), six gastric (6.3 per cent) and three pyloric (3.1 per cent). The exact site of the perforation is not definite in a great number of cases because of presence of edema and exudate. Dissection and identification are not reasons for delay in the repair of perforation. Three perforated malignant gastric lesions were found, two being lymphosarcomas and one an adenocarcinoma.

The method of surgical treatment of the perforation has changed much during this series. There were seventy-four simple closures of the perforation, eighty-seven closures with omental grafts, twenty-three closures with posterior gastro-enterostomies, three subtotal gastrectomies and one gastroduodenostomy. In earlier years the closure was usually done with a purse-string of catgut reinforced with silk. During the period in which the posterior gastro-enterostomy was in vogue the perforation was closed with two or three layers of interrupted silk Lembert sutures. The operative notes reveal that the operator attempted palpation of the lumen and thought that obstruction might follow and thus a gastro-enterostomy be necessary. During the past eight years this has

changed to the simplest method of closure: three or four interrupted Lembert silk sutures with omental grafts if easily available. There have been no cases of obstruction of the pylorus or duodenum after this simple closure.

Drainage was instituted in eighty-two cases. The site of perforation was drained fifty-nine times, the pelvis thirty-seven, pelvis and site of perforation seven, right gutter six, abdominal wall thirty-five and the left gutter once. The site of perforation was usually (forty-three cases) drained through a right upper quadrant stab wound. In all cases in which the pelvis was drained it was by use of a suprapubic stab wound.

Postoperative treatment has changed during this period. The first few years that this report covers, gastric suction was not used frequently until abdominal distention became quite marked. There was a great tendency not to allow any liquid or food by mouth for four to six days; this has changed in the past five years to sips of water after twelve hours postoperatively. It is interesting to note that in the first few years of this report food and liquids were not allowed by mouth for several days but that oral medications, such as antispasmodics, cough syrups and cathartics, were given often. Gastric suction is now used almost routinely for twelve to forty-eight hours. Parenteral feedings now include adequate amounts of protein and vitamins while from 1935 to 1943 the feeding usually consisted of only· intravenous saline and glucose. Beginning in 1938 sulfa drugs were used in most cases, either intravenously, subcutaneously or orally, when the patient was able to take them. Since 1943 penicillin has been used in most cases. Early ambulation was instituted in 1944 and so far the patients seem to do better although this series is too small to report more than a trend.

The usual complications of wound infection, peritonitis and pulmonary disease were noted in about the same frequency as

reported by other authors. The complications in order of frequency are listed in Table v.

MORTALITY

The overall mortality of this series is 26 per cent, and excluding those not

TABLE v

Complications	No. Patients
Wound infection	24
Pneumonia	21
Peritonitis	17
Atelectasis	16
Subhepatic, subdiaphragmatic abscess	7
Evisceration	6
Intestinal obstruction	5
Bands (small bowel)...3	
Volvulus (small bowel)...1	
Duodenum...1	
Paralytic ileus, severe	3
Empyema	3
Hemorrhage	3
Septicemia	3
Thrombophlebitis	2
Delirium tremens	2
Cardia decompensation	2
Uremia	2
Parotitis	1
Gastric fistula	1
Jaundice	1
Lung abscess	1
Pulmonary embolism	1

operated upon the mortality is reduced to 20 per cent. Many factors are present which influence the mortality of those with this acute surgical emergency. Briefly these are as follows: the time interval between perforation and surgery, the age of the patient, correct diagnosis, anesthesia, surgical procedure, co-existing medical diseases, complications and use or non-use of chemotherapeutic and antibiotic agents.

If the patient had the perforation and received reparative surgery within the first three hours, the chances for recovery were good, the mortality rate being only 4.7 per cent for this period. From the third to sixth hour after perforation the mortality rate rose to 11.6 per cent and then to 12.4 per cent for the six to twelve-hour period following perforation. After twelve hours the mortality rose sharply, 37.5 per cent for the twelve to eighteen-hour and

the eighteen to twenty-four-hour periods. Between twenty-four to thirty-six hours the mortality rate was 50 per cent and climbed to 100 per cent for the thirty-six to forty-eight-hour period. The mortality rate dropped to 50 per cent for all cases

TABLE VI

Ulcer Site	No. Cases	Per cent of Cases	No. Cases Died	Mortality (Per cent)	No. not Operated	Mortality of Operated Cases (Per cent)
Gastric ..	91	45.5	24	26.3	6	19.7
Duodenum	79	39.5	23	29.1	4	24.0
Pylorus..	30	15.0	6	20.0	2	13.3

in which perforation had existed for forty-eight hours or over. The last drop in mortality might be explained as a walling-off of the perforation thus showing a tendency toward spontaneous healing.

This series of cases further substantiate the often proved fact that the mortality rate rises steadily with the older group of patients. This may be explained in part by their greater number of concurrent and complicating illnesses, such as pathologic cardiac states, uremia, diabetes, jaundice, malnutrition, etc.

It was quite difficult to determine accurately the site of the perforation in most cases. As pointed out previously gastric ulcers predominated in this series with the general mortality of 26.3 per cent and a mortality of 19.7 per cent for those receiving surgery; duodenal ulcers produced a general mortality of 29.1 per cent and a mortality of 24 per cent for those receiving surgery and pyloric ulcers caused a general mortality of 20 per cent and a mortality of 13.3 per cent of those who underwent operation. (Table vi.)

Correct diagnosis was made in 95.5 per cent of the cases. Those incorrectly diagnosed as acute appendicitis did not affect the mortality. Those diagnosed as cholecystitis with cholelithiasis and coronary

artery disease directly affected the mortality since the delay placed the patient in the time period group in which the mortality for all patients ranged from 37.5 to 100 per cent. Of these three patients only one survived the surgical procedure and the patients that died might easily have lived if the correct diagnosis had been made and the proper therapy instituted earlier.

During the period of this report many of the anesthetics were given by young and often inexperienced house officers and nurse anesthetists. The problems of anesthesia were not well understood by the anesthetists and surgeons. Intratracheal anesthesia with suction and controlled respirations was seldom attempted. Postoperative pulmonary complications were common. (Table v.) The mortality rate of the patients that had spinal anesthesia was 12 per cent in comparison to the 21 per cent mortality of those given general anesthesia and the 42 per cent mortality of those given a combined general and spinal anesthesia. Thus, it would seem that general anesthesia should be avoided whenever possible unless it is administered by a competent, well trained physician-anesthetist.

The mortality trends have been divided into three periods of four years each: The period of 1935 to 1938 reveals a general mortality of 28.5 per cent of all patients with a 24.2 per cent mortality rate for patients undergoing operations. This is the period in which the more complicated surgical procedures such as the two- and three-layer closure of the perforation, posterior gastro-enterostomy, transverse incision and suprapubic drainage of the pelvis were common. The period from 1939 to 1942 showed a drop in the general mortality to 20 per cent and to 15 per cent for those receiving surgery. This period was marked by the rather general abandonment of the transverse incision, the multiple layer closure of the perforation, the posterior gastro-enterostomy following closure of the perforation and the

suprapubic drainage of the pelvis. Chemotherapeutic agents were used rather frequently locally, orally, subcutaneously and intravenously. Undoubtedly these drugs saved many patients indirectly through their action in treating pulmonary complications as well as the peritonitis and wound infections. The period of 1943 to 1946 showed only a general mortality of 11 per cent with a drop to 7.5 per cent for the patients receiving surgery. Antibiotic agents made their entrance into this period and with the chemotherapeutic agents probably lowered the mortality by their combined effects on peritonitis and the prevention and treatment of pulmonary complications. Also during this period the simple, single layer closure of the perforation with omental graft was re-emphasized and less frequent drainage of the peritoneal cavity was carried out.

Eviscerations made a difficult problem. Of the six eviscerations, only one patient recovered from it. In an analysis of the deaths of those with evisceration three patients had transverse incisions and one each a right rectus and right paramedian incision. Three patients had spinal anesthesia, one had general and one a combined general and spinal anesthesia. Two of these patients had had perforation over twelve hours prior to surgical intervention. The one patient that had an evisceration who lived had had the perforation occur only six hours prior to surgery; the abdomen was opened through a right paramedian incision under spinal anesthesia and a simple, single layer closure of the perforation of the ulcer was made with the addition of an omental graft.

Postoperative mechanical obstruction was another problem that caused a high mortality figure. There were three deaths, one due to a volvulus and two due to angulation obstruction of the small intestine by adhesive bands. Interestingly enough, all of those patients who died had suprapubic drainage of the pelvis.

There were two patients with diabetes and these patients died within three days following surgery. Both were almost moribund on admission to the hospital. Two patients developed delirium tremens and one of them died forty-eight hours postoperatively. Two patients had cardiac lesions which became progressively worse during their postoperative period and one died in cardiac failure. One patient developed jaundice postoperatively and one a gastric fistula. Both of these complications were fatal.

The most common complications of this series remain as wound infection, peritonitis and some pulmonary pathologic process. They play a major rôle in whether or not the patient will recover. The most important advances in therapy in the prevention and treatment of these complications have been the use of chemotherapeutic agents and antibiotics. In the prevention or attenuation of wound infection, peritonitis and pulmonary diseases such complications as evisceration, subhepatic and subdiaphragmatic abscess, empyema, septicemia and lung abscess become less frequent.

SUMMARY

Two hundred patients with perforated ulcers of the stomach and duodenum were seen at University Hospital in a twelve-year period. The overall mortality rate was 26 per cent and 20 per cent for those who underwent operation. Sex, race and seasonal relationship did not show any prognostic trends in this series. The age of the patient was quite important in that the mortality rate rose with the age of the patient. The youngest patient was nineteen and the oldest seventy-six years of age. Sixty-two per cent of the patients were classified as laborers and the absence of the high-strung "ulcer type" patient was noted. Eighty-nine per cent of the patients had a history of previous gastric disturbances and 30 per cent a past history of moderate use of alcohol.

Correct diagnosis was made in 95.5 per cent of cases by use of history and examination which revealed a board-like rigidity

of the abdomen, muscle spasm, a quiet abdomen by auscultation, leukocytosis and x-ray evidence of free air in the peritoneal cavity. The most commonly used anesthetic was spinal and with it the patient mortality was lower (12 per cent) than that of general (21 per cent) and the combination of general and spinal (42 per cent). The abdomen was opened in many ways and the transverse incision was virtually abandoned after 1938. The right upper rectus incision became the popular choice followed closely by the right upper paramedian. Both of these incisions gave adequate exposure. The ulcer perforation was found to be gastric in 45.5 per cent, duodenal in 39.5 per cent and pyloric in 15 per cent of the patients. The lowest mortality rate was noted with the pyloric perforations and the highest with the duodenal perforations. (Table vi.) Three perforated malignant lesions were found and those patients died following closure of the perforation. During the series the more complicated procedures, such as multiple layer closure of the perforation and posterior gastro-enterostomy, were discarded for the simple, single layer closure and the omental graft because of a mounting mortality rate and more frequent complications. Suprapubic drainage has not been used for eight years and of the three deaths complicated by mechanical intestinal obstruction suprapubic drainage was present in each case. Postoperative therapy now consists of gastric siphonage for at least twelve to forty-eight hours, sips of water twelve hours postoperatively, adequate parenteral feedings with vitamins and amino acid preparations, chemotherapeutic and antibiotic agents prophylactically to combat and prevent peritonitis, wound infections and the pneumonities.

CONCLUSIONS

1. Two hundred consecutive cases of perforated gastric and duodenal ulcers are reported covering a twelve-year period.

2. The age of the patient is important to the prognosis of the case.

3. The earlier the diagnosis is made and reparative surgery instituted, the better the prognosis.

4. Spinal anesthesia in this series was the safest anesthetic.

5. The upper right rectus or upper right paramedian incisions give adequate exposure, and the percentage of wound eviscerations is less than with transverse incisions.

6. A simple, single layer closure of the perforation with omental graft if available is all the reparative surgery that is needed.

7. Suprapubic drainage increases the risk of intestinal obstruction and has been virtually discarded in this clinic.

8. Chemotherapeutic and antibiotic agents should be used routinely.

9. Gastric siphonage is indicated postoperatively.

10. Parenteral alimentation with adequate intake of vitamins and protein is necessary.

11. Early ambulation has not had sufficient trial in this type of problem.

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McElhinney and Holzer reviewed over 300 cases of acute gastro-duodenal perforation occurring in a twelve-year period at a general hospital. They found that the recent operative mortality has been halved because of prompter surgery plus the supplemental use of adequate doses of sulfa-diazine and the antibiotics. (*Richard A. Leonardo, M.D.*)

BRACHIAL PLEXUS ANESTHESIA*

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SINCE the introduction by Kulen-kampff[4] of a technic for producing brachial plexus anesthesia by injection in the supraclavicular fossa, this route has been the one most frequently employed. The procedure has not been widely used,

Fig. 1. Relationships of the brachial plexus in the supraclavicular region, left side. The position of the first rib is indicated by broken lines.

however, probably because of the difficulty of mastering the technic.

Brachial plexus anesthesia permits operation on the upper extremity in head injuries and in patients in whom thoracic complications, shock or other factors make it unwise to use general anesthesia. It facilitates tendon repair, as the patient may by contracting muscles facilitate the surgeon's identification of tendon stumps with minimal exposure. Brachial plexus anesthesia abolishes vasoconstriction in the upper extremity, permitting a better eval-

uation of the circulation when vasospasm and vascular injury must be differentiated.

The contraindications to the procedure are two in number: specific sensitivity to procaine and infection in or about the supraclavicular fossa.

Among the complications referred to in the literature,[3,5,7,9] namely, hematoma of the supraclavicular fossa, pneumothorax, residual paralysis and pressor effects due to the drug employed, the first two may be overcome by exactness in technic and the use of small caliber needles. Residual paralysis, according to Lundy,[7] does not result if procaine is employed. The transient pressor effects of procaine following injection are largely overcome with adequate preoperative sedation with morphine and by the addition of epinephrine to the anesthetic solution.

ANATOMY OF THE BRACHIAL PLEXUS

The brachial plexus is derived from the anterior primary divisions of the fifth to eighth cervical nerves and the first thoracic nerve, with occasional contributions from the fourth cervical and second thoracic nerves. These nerves emerge in the posterior triangle of the neck between the scalenus medius and scalenus anterior muscles, extend in a downward and lateral direction invested on the outer surface by prevertebral fascia and converge to form three trunks. The upper trunk is formed by the nerve roots of C5 and C6, the root of C7 forms the middle trunk and the nerve roots of C8 and T1 form the lower trunk of the plexus. These trunks give off branches which supply the muscles of the shoulder girdle and converge as the first rib is reached. (Fig. 1.)

As shown in Figure 2 the plexus lies between the scalenus muscles in a fascial

compartment which is formed anteriorly and laterally of prevertebral fascia. Medially the plexus is in contact with Sibson's fascia which attaches to the transverse process of the seventh cervical vertebra above and extends anteriorly and posteriorly between the sheaths of the scalenus anterior muscle in front and the scalenus medius muscle behind and terminates below at the medial border of the first rib.

The cervical pleura covered by Sibson's fascia rises above the sternal end of the clavicle because of the obliquity of the first rib (Fig. 4) although it rises nowhere above the head of the first rib. On the average the cupula pleurae rises about 1 inch higher than the clavicle.

As the plexus comes into relation with the first rib it retains its outer investment of prevertebral fascia, but is no longer invested on its medial surface, Sibson's fascia having terminated at the medial border of the first rib. The upper surface of the rib, therefore, now forms the floor of the compartment in which the plexus is situated.

Relations of the Brachial Plexus at the First Rib. Medially the plexus is in relation with Sibson's fascia and the cupula pleurae. Inferomedially the plexus is in contact with the upper surface of the first rib which partly encircles the lung below its apex. The subclavian artery lies anterior to the plexus between the scalenus muscles. Posterior to the plexus and partly covered by it is the insertion of the scalenus medius muscle. In this location the first rib extends in a nearly anteroposterior direction.

Cords of the Plexus. As the plexus crosses the first rib three cords are formed, named according to their relation to the subclavian artery (Figs. 1, 3 and 4.) The lateral cord, as the musculocutaneous nerve, supplies the arm flexors and the lateral aspect of the forearm and contributes to the median nerve. The medial cord supplies the medial aspect of the arm, forearm and hand; it also contributes to

the formation of the median nerve, which has its origin in the axilla anterior to the subclavian artery, and supplies flexor muscles in the forearm and has a limited distribution in the hand. The medial cord is adjacent to the first rib. The posterior
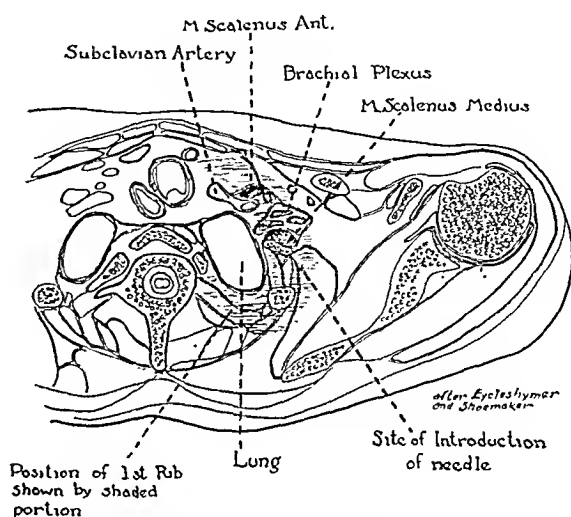
FIG. 2. Transverse section of the trunk at the lower portion of the first thoracic vertebra. The position of the right first rib is shown by shading. The plexus is seen to be in a fascial compartment between the scalenus muscles. (After Eycleshymer and Shoemaker.)

cord, unlike the other two, is extensor in function. It gives off the axillary nerve which has an important skin distribution on the posterolateral aspect of the arm in its upper part, and continues as the radial nerve which supplies the extensor aspect of the lower arm, forearm and hand.

Other Branches of the Brachial Plexus. The branches of the plexus which are given off cephalad to the first rib and diverge from the plexus necessarily escape inclusion in routine block performed at the lateral border of the first rib. Those supplied by the nerves C5, 6 and 7 can be blocked, however, by a supplemental injection anterolateral to the transverse process of the sixth cervical vertebra (tubercle of Chassaignac) as suggested by Labat.[6]

This injection interrupts conduction over all these branches mentioned with the exception of the medial anterior thoracic

nerves (C8, T1), but this is not of much practical importance.

It is extremely important, however, to reach the intercostobrachial nerve (T1, 2) which does not enter into the formation of the brachial plexus, but which supplies

such that injection will necessarily be in the proper compartment. In order to accomplish these objectives, the rib is "walked" from posterior (where it is most readily palpable and superficial) to anterior, in which direction the plexus
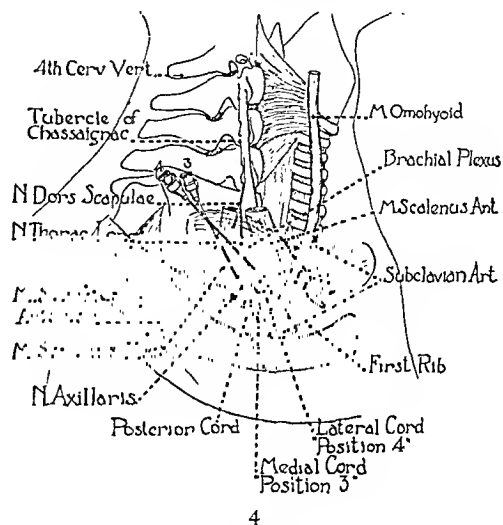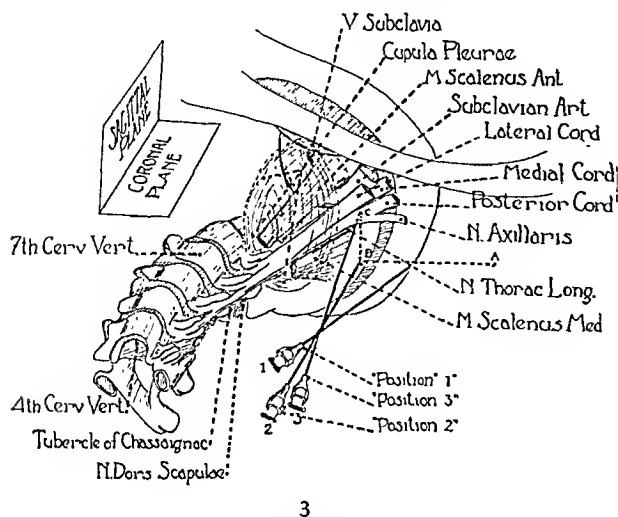
Fig. 3. The relations of the brachial plexus in the right supraclavicular fossa. The diagram illustrates the brachial plexus in perspective visualized from the standpoint of the operator who stands facing the right shoulder of a supine patient whose head is turned and inclined to the left. The position of the cupula pleurae is shown by shading.

Fig. 4. Lateral view of the supraclavicular region. The method of injecting on the lateral and medial aspects of the plexus is shown.

the posteromedial aspect of the arm. This nerve, or nerves, comes off the corresponding intercostal nerves on the lateral thoracic wall, and after traversing the axilla beneath the axillary fascia, becomes superficial on the upper inner surface of the arm to continue subcutaneously as far distal as the elbow, having joined the medial brachial cutaneous nerve. The intercostobrachial nerve is relatively inaccessible through the supraclavicular fossa although Miltner and Chao[9] state that it can be blocked by this route.

TECHNIC OF BRACHIAL PLEXUS ANESTHESIA

The method here advocated, for which no claim of priority is made, takes advantage of the fact that the plexus traverses the first rib and utilizes the paresthesia first obtained as a means of identifying the point where the plexus traverses the rib, and as a means of orienting the needle to the various divisions of the plexus. At this point the fascial relationships are

will be found from the arbitrary starting point employed. The rib acts as a gauge of depth of the needle and serves to guide the needle toward the plexus without danger of pleural puncture.

Materials Required. Procaine of 1 and 2 per cent to each ounce of which five drops of 1–1000 epinephrine has been added is used. The use of three needles is preferable. A No. 20 gauge, 1½ inches long, is used for injection of the plexus itself; an infiltration needle, No. 22 gauge, is used for the injection of the intercostobrachial nerve, and a shorter No. 22 gauge needle may be used for making the skin wheal and the injection at the tubercle of Chassaignac. Ordinary glass syringes of 10 to 30 cc. capacity are employed if the Luer-Lok type is not available.

Preparation of the Patient. Preoperative sedation should consist of ¼ or ⅙ gr. of morphine given thirty minutes beforehand. Barbiturates may create restless activity on the part of the patient, making it

difficult to detect impending procaine reaction; they are best used to treat such reactions after they appear.

The patient should be supine, his head near the end of the table and inclined to the side opposite that to be injected. A pillow interferes with the procedure. The skin preparation includes the lateral neck, supraclavicular fossa and the axillary aspect of the upper arm.

Procedure. The relationships of the supraclavicular fossa are now as shown in Figure 3 (right side) as the operator stands at the head of the patient. The posterior portion of the first rib is palpated, its forward course gauged and a wheal made in the skin at a point overlying the rib and mid-way between the anterior border of the trapezius and the clavicle.

The No. 20 needle is introduced through the wheal and in a somewhat lateral direction; this permits exploration at a safe distance from the dome of the lung. The needle is then worked cautiously medialward until it finds the first rib; it is then at point "B" or "Position 2."

The needle is then advanced in a forward direction along the rib until it strikes the plexus. The medial cord will, as a rule, be contacted first, as diagrammed in Figure 4 ("Position 3"). Ten to 15 cc. of procaine solution are now injected. The point of the needle is now medial to or "underneath" the plexus.

If the needle is then withdrawn and pushed forward again but in a direction paralleling the rib, it will strike the lateral cord. (Fig. 4, Position 4.) A similar amount of procaine solution is again injected.

The posterior cord is found by placing the needle in a position intermediate to the two preceding positions and again injecting procaine in the same amount. Having injected the plexus on its medial, lateral and posterior aspects, procaine is infiltrated along the superior surface of the first rib to a point approximately 4 cm. posterior to the plexus. Care should be taken that this latter injection be made

deep to the cervical fascia and along the lateral aspect of the rib.

It is important to withhold injection of each cord of the plexus until a paresthesia has been obtained. Reliance should be placed on the observance of a definite muscle twitch corresponding to the distribution of the cord sought and not upon the patient's subjective sensations. Such motor paresthesias should always be obtainable for the medial and lateral cords although an extensor twitch indicating the posterior cord is, for some obscure reason, very difficult to obtain. Paresthesia is more difficult to elicit after a little procaine has been injected in the region.

Supplementary Injections. For anesthesia above the elbow infiltration of the intercostobrachial nerve is required. Using the long infiltration needle, a subcutaneous barrier of 1 per cent procaine is placed across the inner surface of the arm at the lateral boundary of the axilla; this should extend from the posterior border of the biceps muscle backward for a distance of 4 or 5 cm. transverse to the long axis of the arm.

In order to obtain anesthesia in the region of the upper arm and shoulder, injection at the tubercle of Chassaignac as described by Labat[6] is required. The transverse process of the sixth cervical vertebra lies opposite the cricoid cartilage. A wheal is made in the skin at a point overlying this process, lateral to the sternocleidomastoid muscle, and the needle is passed between the scalenus muscles to the process. When paresthesia is obtained, 5 to 10 cc. of 1 per cent procaine is injected, depositing some of the procaine at the anterolateral aspect of the tubercle and some above and below this between the scaleni. The total amount of procaine injected should not exceed 60 cc. of 2 per cent solution or its equivalent.

Signs of Anesthesia. Motor function and sense of pressure are usually not lost. Motor weakness, analgesia, loss of position sense and subjective sensations of increased weight and warmth of the extremity, how-

ever, indicate the onset of satisfactory anesthesia. Tests of skin sensation frequently defeat their purpose by creating apprehension in the mind of the patient.

RESULTS

The technic outlined was used by the writer on 101 cases of upper extremity

TABLE 1

	Fingers to Wrist		Forearm to Elbow		Arm and Shoulder	
	No.	Per Cent	No.	Per Cent	No.	Per Cent
Total cases.........	25	..	37	..	39	
Failure						
Psychologic......	2	8	0	0	0	0
Duration.........	1	4	2	5.4	2	5.13
Technical........	1	4	1	2.7	3	7.68
Other...........	0	0	0	0	1	2.50
Total failures.......	4	16	3	8.1	6	15.4

Percentage of unsuccessful results ..12.85%
Percentage of successful results 87.14%

Technical Failure. These cases represent failure to obtain anesthesia in a part of the upper extremity, so that the necessary surgical work could not be carried out. *"Duration Failure"* indicates those in which supplementary anesthesia, either an additional block or general anesthesia was required because anesthesia wore off before surgery was completed. *"Psychologic Failure"* was applied only to two cases with wrist level injuries who insisted upon general anesthesia, although the extent of the muscular relaxation and other signs indicated a good block up to the region of the shoulder. *"Other"* indicates that supplementary anesthesia was given but the reason for giving it is not ascertainable from the records.

injury in Evacuation Hospitals of the United States Third Army in Europe in 1944 and 1945. In all these cases, the writer also acted as surgeon. The injuries in this group of cases were of all grades of severity and involved all portions of the upper extremity including the shoulder. The Kulenkampff technic had previously been tried; and although very successful in some hands, yielded success in only 66 per cent of cases in the author's hands.

The ideal sought was the production of anesthesia sufficient to permit surgery, débridement, nerve exploration, reduction of fractures, tendon suture, etc., to be carried out without complaint of discomfort or annoyance by the patient. When this result was obtained, it was recorded as a success. Failures were recorded according to cause. The results are tabulated in Table 1.

COMMENT

The use of pentothal sodium to supplement blocks which were "failures" from any cause furnished a good index of the degree of regional anesthesia present. The average amount of this drug used for this purpose was .45 Gm.; .3 Gm. was frequently sufficient to produce and maintain sleep while surgery was completed, indicating that some degree of regional anesthesia was present. ·

The results in the third group of cases involving the arm and shoulder indicate the value of Labat's supplemental injection at the tubercle of Chassaignac. Of these thirty-nine cases there were nine which involved the upper third of the arm and/or the shoulder; in this group, with Labat's supplement, there was one failure. In the remaining thirty cases in which the most proximal wound level was the junction of the upper and middle thirds, and Labat's supplement was not given, five were failures. Obtaining anesthesia at the higher level is, of course, more difficult than in the more distal, which suggests strongly that this supplement is of definite value in any above-elbow procedure.

The last thirty-five consecutive cases include only one failure. In this instance sufficient muscle relaxation to reduce a shoulder dislocation could not be secured. Brachial plexus anesthesia is not recommended for this purpose although it is occasionally successful when supplemented.

This type of anesthesia was found to be particularly suited to poor risk patients and cases complicated by other injuries, shock or poor general condition from any cause. Shock was observed to improve after the onset of anesthesia in some

cases; when it failed to improve it usually did not worsen unless the operating time was prolonged. In the presence of shock the duration of anesthesia proved to be considerably greater, at times lasting over three hours. When supplementation was needed, the amount of drug required was significantly diminished, indicating that the block had not been entirely without effect. The absence of vasoconstriction in the blocked extremity was frequently instrumental in the saving of structures which had at first appeared to be ischemic.

Reaction to procaine, other than readily controlled pressor effects, was not observed in this group of cases nor were complications observed other than hematoma of mild degree.

SUMMARY

Infiltration of the brachial plexus through the supraclavicular fossa affords satisfactory anesthesia in the upper extremity when other factors preclude the use of general anesthesia. The brachial plexus crosses the first rib in an investment of fascia derived from the sheaths of the scalenus muscles and the prevertebral fascia; its medial aspect lies in relation to the first rib. The derivation and divisions of the plexus are described; these relationships indicate the need for injections at various points to ensure adequate infiltration and satisfactory anesthesia.

The technic advocated utilizes the constant relationship of the plexus and the first rib as a means of locating the plexus. By this method it is possible to inject two or more cords of the plexus individually, which provides increased likelihood of successful anesthesia. The necessity of injecting the intercostobrachial nerve for surgery in the arm, and at the tubercle

of Chassaignac for surgery about the shoulder must be borne in mind. Observance of a motor twitch in the arm muscles, rather than subjective sensations reported by the patient, is believed to furnish a more reliable indication of contact with the plexus.

The results obtained by this method of administration in the writer's hands were good in 87 per cent of cases. The failures are tabulated according to cause; not all the failures were failures of the method itself. The anesthesia obtained permitted major surgery to be carried out with no complaint of pain on the part of the patient in the successful cases. The average duration of anesthesia was one and three-quarter hours; in cases in which shock was present satisfactory anesthesia not infrequently lasted for three hours.

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CONSTRUCTION AND CARE OF THE PERMANENT COLOSTOMY

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ALTHOUGH most features of the abdominoperineal resection of Miles operation for carcinoma of the rectum have become standardized over the past forty years, the construction of the end colostomy is still performed by a variety of methods. Despite the enormous literature dealing with the basic principles of other portions of the operation, it is difficult to sift out the salient factors in the colostomy construction that insure a functional result compatible with successful social and economic rehabilitation of the patient.

Management of the end colostomy has been thoroughly studied and methods for management outlined in detail by several authors.[1,2,4,13] These methods presuppose the presence of a satisfactorily constructed colostomy for success. In our clinic we see failure of patient adjustment due to structural defects and to inadequate training of the patient. The colostomy bag is a badge of failure on both counts. This matter assumes great importance at this time when patients are aware of sphincter-saving operations and brings pressure on the surgeon for operations compromising fundamental principles of cancer surgery. Most patients facing the problem of colostomy revolt at the thought of the "bag" rather than the abnormal opening upon the abdominal wall. This appliance is responsible for much of the aversion to colostomy and should be eliminated following rectal resection. The avidity with which patients turn to sphincter-saving operations is evidence that all are not able to adapt to colostomy control regimens of one kind or another. This situation warrants our examination more closely of the factors entering into satisfactory end colostomy construction.

Review of technics advocated by surgeons widely experienced in this field shows no pattern of evolution. Most technical papers dealing with operative technic give little space to the details of the construction of the colostomy.

Miles[9] advocates colostomy through a muscle-splitting incision $1\frac{1}{2}$ inches medial to the anterior superior spine of the ileum and avoidance of colostomy through the left rectus incision. Emphasis is placed upon the size of the muscle splitting wound which should be just large enough to admit the index finger. This size is recommended to prevent small bowel herniation. The bowel wall is anchored to the incision with silkworm sutures. No closure of the lumbar gutter is advised.

In 1935 Lahey[7] favored a 1 to $1\frac{1}{2}$ inch protrusion of the bowel above the skin level, with anchorage of the bowel by suturing epiploic appendages to the wound and closure of the lumbar gutter. In 1946[8] the same author advises a 3 to 4 inch projection of bowel above the skin level, with a snug closure of the wound about the bowel and closure of the lumbar gutter as previously.

T. E. Jones[6] prefers to bring the colostomy out through the operative incision. However, if the loop is too short for this, it should be brought out through a left McBurney incision. This preference for colostomy close to the midline is so that the patient will appear symmetrical with his colostomy dressing. Jones does not advocate closure of the lumbar gutter.

Cattell[2] believes that end colostomies should project $1\frac{1}{2}$ inches above the skin

level and should be well anchored to prevent prolapse or recession into the wound. A ½ inch projection of mucous membrane is desired as an end result. The bowel should be brought out through the wound and the peritoneum closed snugly about it while the fascia is closed loosely to prevent postoperative stenosis. In his experience late stricture is due to bowel wall receding and reaching the level of the skin.

Rankin[7,10] prefers to construct the end colostomy through a stab wound in the left lower quadrant and has found this easiest to make and easiest to control. This stab wound should be only 5 cm. in length and the peritoneal opening even smaller so that it will hug the bowel closely. The bowel is maintained in position by a Payr clamp and a piece of gauze is wrapped about the bowel down to the level of the peritoneum. No sutures are placed in the bowel wall or the epiploic appendages. Although purse-string closure of the lumbar gutter is advised in loop colostomy of the sigmoid, it is not recommended for end colostomy.

Daniel F. Jones[5] brought the colostomy through the operative incision and advised closure of the lumbar gutter. He also cautioned against the use of sutures between the bowel wall and the abdominal wall.

End colostomy through a left paramedian incision is advised by Shedden,[13] the bowel being drawn through a split in the proximal third of the left rectus muscle. This, he believes, is conducive to better control. Closure of the lumbar gutter is advocated.

Singleton[12] reporting on his one-stage perineo-abdominal resection of the rectum favors colostomy through a muscle-splitting incision on the left side. Colostomy through the midline incision may be done but he believes the former is less likely to result in herniation of the bowel. He does not close the lumbar gutter.

David[3] brings the colostomy out through a right or left muscle-splitting incision

medial to the anterior superior spine of the ileum or at the lower angle of the operative incision. No attention is given the lumbar gutter.

COMMENT

Evaluation of our own results on the Fourth Surgical Division of Bellevue Hos-
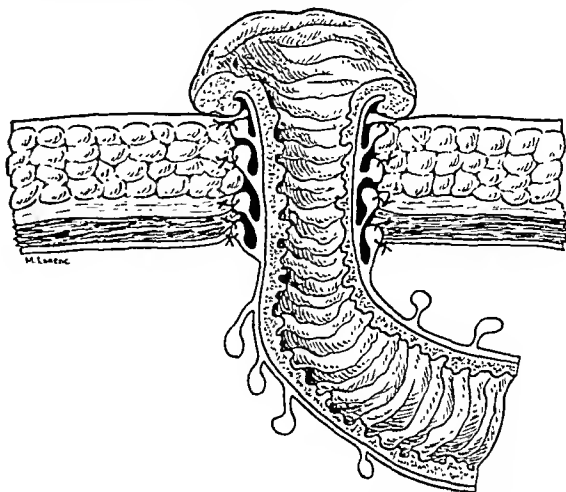
FIG. 1. Cross section of colostomy showing suture of appendices epiploica to abdominal layers.

pital resolves this problem into two sets of factors; (1) those concerned with morbidity and mortality and (2) those relative to rehabilitation of the individual.

Almost everyone agrees that no sutures should anchor the bowel wall to any portion of the incision. However, there is a definite need to stabilize the bowel. Whenever possible the epiploic appendages should be used for this purpose. There have been no complications from this procedure. This measure not only maintains the bowel in the desired relation to the abdominal wall but also obliterates the potential space existing around the bowel before sealing off of the peritoneum has taken place. This point warrants consideration as we have seen small bowels herniate through a colostomy stab wound with a fatal result. Most writers use the adjective "snug" in describing the closure of the wound about a colostomy but few give a method of quantitating this snugness. We have found that one's index finger should fit comfortably in the peritoneal opening beside the bowel, as has been advocated

by Cattell. The fascia need not be closed as tightly as the peritoneum. The fixations of epiploic appendages to peritoneum, muscle, fascia and skin hold out the bowel wall so that it fills the defect more adequately than if the mural structures were tightly closed about it. This method prevents inadvertant jeopardizing of the blood supply by constriction of the mesentery of the bowel wall in the wound. We have not had to deliver more bowel postoperatively because of slough of the bowel end. (Fig. 1.)

We have not encountered obstruction due to small bowel entering the opening between the bowel and the abdominal wall in the lumbar gutter, and do not consider closure of the space an important point. The literature reveals no universal opinion on its necessity. This step is advised only in those instances in which the loop is brought out through a stab wound in the left lower quadrant. When the loop is brought through a paramedian or rectus-splitting incision, the internal hiatus between bowel and abdominal wall is too large for closure. We have seen no instance of obstruction due to the small bowel becoming involved in the space between the colostomy and lateral parietal wall.

Morbidity and mortality have not been affected by the site used for colostomy. Where the colostomy has been brought out through the operative incision, we have had no difficulty with wound infection. This can be attributed to the thirty-six- to forty-eight-hour period allowed for sealing of the wound and the 2 to 3 inch projection of the loop and the routine preoperative use of succinylsulfathiazole. Rectal tubes or catheters may be sewed in a well projecting end colostomy to conduct feces and gas away while the wound is in the early stages of healing. We have not had success with this measure in the left colon and have come to depend on other factors to protect the wound from becoming infected.

The functional result and rehabilitation of the patient depend on the formation of a well projecting tight stoma. This should project 1 to 2 inches above the skin level after healing has taken place. This can be obtained if 2 or more inches of bowel protrude above skin level when the incision is closed. This projection can be roughly estimated before closure is begun and more bowel may be mobilized if necessary by dividing lateral peritoneal attachments. Occasionally this may necessitate freeing of the splenic flexure. Proper maintenance of the bowel protrusion is facilitated by suturing epiploic appendages to the skin. After the colostomy has been opened, the mucous membrane everts until it reaches skin level where it heals to the skin and its own serous surfaces adhere leaving a protrusion about one-half the original size. This process forms a tight stenotic rim at the skin level which barely admits the little finger at the end of a month but shows no tendency to become progressive thereafter. This feature is constantly found in the colostomies of those who make a satisfactory adjustment and wear only a small dressing. If the mucosa lies below the skin level, there will be a tendency toward prolapse of the bowel through the stoma in the early stages of healing, followed by progressive stricturing at the skin level necessitating later operative revision. Much has been written in the past about the proper degree of tension for suspension of the bowel in the wound so that late prolapse would be prevented. This has not constituted a problem when the proper stoma has been fashioned.

We have had no instances in which simple loop colostomy has proven satisfactory from the functional standpoint. Complete division of the bowel does not ameliorate the situation. The presence of two loops of bowel in close proximity in the wound fails to produce the tight block of tissue about the stoma associated with good control. In these unsatisfactory colostomies we have seen prolapse of the bowel and orifices that discharge almost continuously so that a bag is necessary.

Rehabilitation must be a simple arrange-
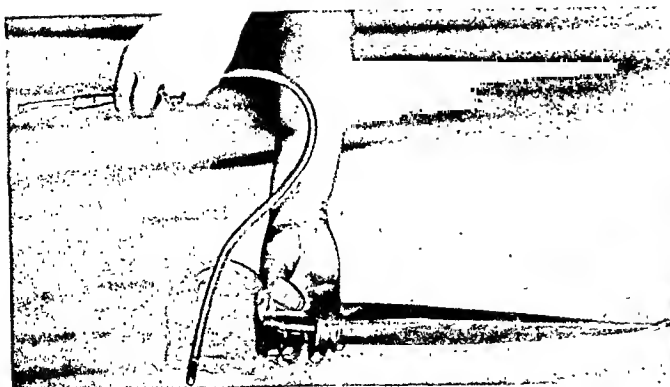
Fig. 2.
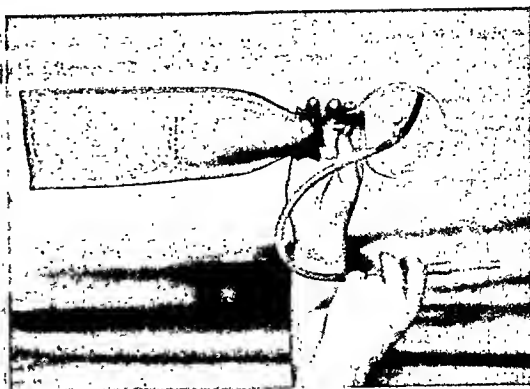
Fig. 3.

ment and lend toward adequacy and freedom from soiling at least for twenty-four hours. After healing occurs and the colostomy has reached its end result in healing so that the mucous membrane pouts above the skin 1 to 2 inches and the skin about the colostomy has stenosed down to its limit, proper instruction must be given the patient by the surgeon. This ideal is acquired in about four weeks.

The diet is a general one omitting only those articles of food which the individual patient knows by experience causes loose stools. On arising the patient irrigates the colostomy with about 1 pint of tap water using the simple devise here illustrated. (Figs. 2 to 4.) It is a glass bowl type of colostomy irrigator with a large opening. It is held against the abdomen at the colostomy. Then in front of the bowl is a small hole allowing the use of a 26 French rectal tube with catheter. Attached to the bottom of the bowl is a long rubber bag about 13 inches long through which the stool comes out into the glass bowl and down the rubber tube into the toilet on which the patient is sitting. When the irrigation is over, the patient sits there a while and then cleanses himself. He then puts on a dressing and a snug fitting abdominal support. The bulk and coldness of the water causes good peristaltic action with complete emptying of the colon. A small piece of gauze is applied to the stoma and the area stays clean for a period of at least twenty-four hours.

Fig. 4.

On such a regimen the patient is able to forget his colostomy, conduct himself as any ordinary individual and carry out his normal occupation with no inconvenience. The dread and fear of a colostomy is thus completely eliminated.

CONCLUSIONS

1. The proper construction of an end colostomy is described.

2. The end result provides a controllable

colostomy which allows normal conduct of the patient.

3. Simplicity and good function are achieved.

4. A new irrigating device is described.

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ACCORDING to A. A. Strauss a preliminary ileostomy or one done at the time of colon resections in a patient receiving sulfasuxidine therapy is perhaps safer for the surgeon to do than to attempt the one-stage closed method of resection of the colon. This statement, of course, does not hold true for surgeons experienced in this latter operation. (*Richard A. Leonardo, M.D.*)

HIDRADENITIS SUPPURATIVA*

ITS CONFUSION WITH PILONIDAL DISEASE AND ANAL FISTULA

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HIDRADENITIS suppurativa is a chronic inflammatory disease of the skin and subcutaneous tissue affecting those portions of the cutaneous surface of the body in which the apocrine sweat glands are located, namely, the axillary, mammary, inguinal, genital and perianal regions.

The disease is much more common than is generally appreciated. In the past it has frequently been obscured under such names as "abscess" or "furunculosis of the axillae or buttocks," "pyoderma," "fistulous disease of the buttocks" and "non-specific granuloma."

It is chiefly a disease of adults. Although the axillae are most commonly affected, any of the aforementioned sites of predilection, singly or in combination, may be involved. The condition usually affects well nourished robust persons who have an oily skin and acne diathesis.

In the early stage of hidradenitis suppurativa the lesion appears as a furuncle, usually axillary. Histologically, at this stage the apocrine sweat glands reveal primary involvement in an inflammatory reaction. The process may spread by means of the lymphatic channels and tissue spaces through the skin and subcutaneous tissue to a chronic stage, associated with draining sinuses, ulceration and undermining. Also in evidence is an attempt at healing as manifested by the thickened bands of scarring, granulation and relatively little cellular infiltration.

There is a predilection of the disease for certain regions of the body by an inflammatory reaction involving the apocrine glands. The apocrine glands, as distinguished from the eccrine sweat glands, are an adult structure activated at the time of puberty. In lower forms the apocrine gland operates as a scent gland of sexual function. These glands are not secretory like the eccrine glands and are frequently found to contain a cheesy material formed by the degeneration of the contents of the gland. Plugging of the ducts and subsequent infection produce the initial lesion which may progress to a chronic phase.

CONFUSION WITH PILONIDAL CYSTS AND ANAL FISTULAS

As a disease entity hidradenitis suppurativa has failed to receive its proper recognition in the current literature. It is not uncommonly confused with pilonidal disease and anal fistula while the converse is also true. (Figs. 1 and 2.) It is our opinion that this fact, in part at least, explains some of the so-called recurrent pilonidal cysts as well as recurrent anal fistulas. Although the perianal or the lower mid-sacrococcygeal region may be involved alone, there is usually axillary evidence of the condition either past or present. It may be necessary to ask the patient a direct question as to axillary involvement since the process in that region may have been quiescent for years. The diagnosis of perianal manifestations of hidradenitis suppurativa is usually not difficult if the disease is thought of in cases of what appears to be extensive anal fistula or pilonidal disease with many sinuses. An examination with the patient under anesthesia may be necessary to enable one to make a differential diagnosis

Fig. 1. *a*, extensive pilonidal cyst disease with multiple draining sinuses mistakenly diagnosed as hidradenitis suppurativa before operation; *b*, after wide excision *en bloc* and before skin grafting.

Fig. 2. Hidradenitis suppurative which was clinically considered to be a pilonidal cyst with multiple sinuses. Minimal involvement of the right axilla of the same patient should have aroused suspicion of hidradenitis.

between pilonidal cyst disease or anal fistula on the one hand and hidradenitis suppurativa on the other.

STUDY OF 388 PATIENTS

Supporting the statement that hidradenitis suppurativa is much more common than is generally appreciated is the fact that in an eight-year period, from January 1, 1940 through December 31, 1947, the condition was diagnosed at the Mayo Clinic in 388 patients, 197 of whom were female and 191 male, or about an equal sex distribution.

The reason that the aforementioned eight-year period was chosen is that prior to 1939, in which year Brunsting's[1] article appeared, there was much confusion in the terminology used and consequently the records will show many different diagnoses in labeling this disease.

In this group of 388 patients the axilla was the most common site of involvement; that is, one or both axillae were involved, alone, or in combination with other sites in 278 patients (72 per cent of the total group of 388 patients). In this group of 278 patients the axilla or axillae were involved alone in 187 instances.

The mammary area was involved alone or in combination with other sites in thirty-two patients (8 per cent of the total group). The oldest patient was a woman aged sixty-nine years. who had hidradenitis suppurativa in subcutaneous tissue under the breasts and also Schimmel-

busch's disease in the mammary glands. Perhaps this chronic cystic mastitis of the Schimmelbusch type could be considered a deep-seated hidradenitis. At least the apocrine glands are involved initially in both diseases.

The groin was involved alone or with other sites in ninety-two patients and the back of the neck in forty-four patients.

The second most common site of involvement was the perianal region. This was the site in 125 patients (32 per cent of the total group) of whom seventy-nine were male and forty-six were female. In more than two-thirds of these (eighty-four patients) there was co-existing single or bilateral axillary involvement. The remaining forty-one patients had peri-anal involvement of the disease alone or with scrotal or labial involvement. It is with this group that our study is particularly concerned. In most of this group of forty-one patients in whom the perianal area *alone* was involved the diagnosis was quite apparent after the history and examination but in four instances the diagnosis proved to be an extensive fistula in ano after examination at the time of operation when the patient was anesthetized. Several other patients gave a history of having undergone an unsuccessful operation for a pilonidal cyst or an anal fistula which actually proved to be hidradenitis suppurativa instead of the disease for which operation had been performed.

TREATMENT

When the disease is far advanced and fails to respond to conservative measures such as roentgen therapy, the involved perianal regions are excised *en bloc*. (Fig. 3.) The excision should include all of the fibrous or inflamed portions of the subcutaneous fat and connective tissue. All

Fig. 3. *a*, extensive hidradenitis suppurativa; *b*, same patient after excision *en bloc* and skin grafting.

sinuses and epithelial skin bridges should be explored and excised. Extensive denuded areas may require skin grafting.

COMMENT

Most patients who have peri-anal hidradenitis suppurativa will have co-existing involvement of other sites of predilection, usually axillary. When the condition affects the perianal area alone as it did in forty-one cases (11 per cent of the group studied), the differential diagnosis should include fistula in ano as well as pilonidal cyst disease.

At least some of the cases of so-called recurrent pilonidal cysts or anal fistulas are actually cases of recurrent or new areas of involvement with hidradenitis suppurativa.

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CLINICAL USE OF OXYCEL IN MINOR ANORECTAL SURGERY*

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STIMULATED by reports in the literature of a new, absorbable hemostatic agent, Oxycel, used in various parts of the body, it was thought that this might be particularly useful in minor anorectal surgery. This report represents our findings in a series of 478 cases in which oxycel was used as a hemostatic agent.

Oxycel is the proprietary name given to cellulose which has been oxidized by the use of nitrogen dioxide or tetroxide converting unoxidized cellulose into polyanhydroglucuronic acid.

pletely absorbed within thirty days with no apparent ill effects or, as in the case of surface application, the gelatinous mass is expelled or can be flushed from the surface of the tissues within a period of three or four days.

TECHNIC

We have used oxycel as a hemostatic agent in a series of 478 cases divided between acute and chronic anal fissure, hemorrhoids and anorectal fistulas. The operative procedures employed adhered largely to the open technic. A hemorrhoi-
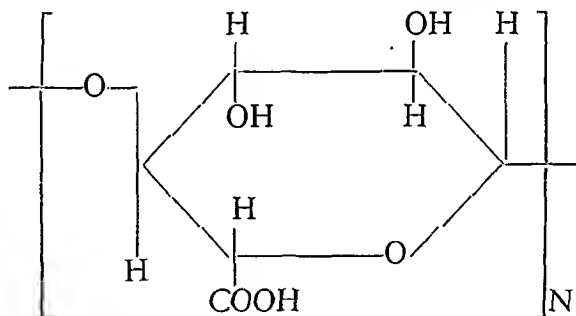
This is an absorbable hemostatic agent giving rise to minimum tissue reaction and it is relatively non-irritating. Pathologically, the tissue reaction is limited to the presence of a few polymorphonuclear leukocytes and the formation of a gelatinous mass which is microscopically absent within a thirty-day period. The specific hemostatic property of oxycel seems to depend on the formation of coagula apparently consisting of salts of cellulosic acid and hemoglobin. Clinically, when oxycel is inserted into a bleeding wound, it turns black, swells and has the adhesive tenacity of a true clot. Subsequently, it forms a gelatinous mass which is com-

dectomy was performed by ligation of the pedicle and excision of the hemorrhoidal mass after the method of Hirschman. All anorectal fistula operations were done by an open method of completely uncovering the fistulous tract and eliminating the internal opening of the fistula. Fissures were excised in their entirety and left open. Suturing within the anorectal canal and at the anal margin was kept to a minimum and was used only to secure blood vessels adequately. It must be stressed that oxycel was not used as a substitute for careful surgical technic for all obvious bleeding from arteries or veins must be ligated. In using this open method

of operation a fair amount of venous and capillary oozing occurs without a demonstrable point of hemorrhage. An open incision or wound in this area is particularly suitable for such a hemostatic type of dressing.

It must be stressed that this oxycel "whistle" does not act as a foreign body due to its size. It does not resemble the old, large sized "whistle" in any way. It has been our experience that the method of choice is number (3), the oxycel "whistle,"
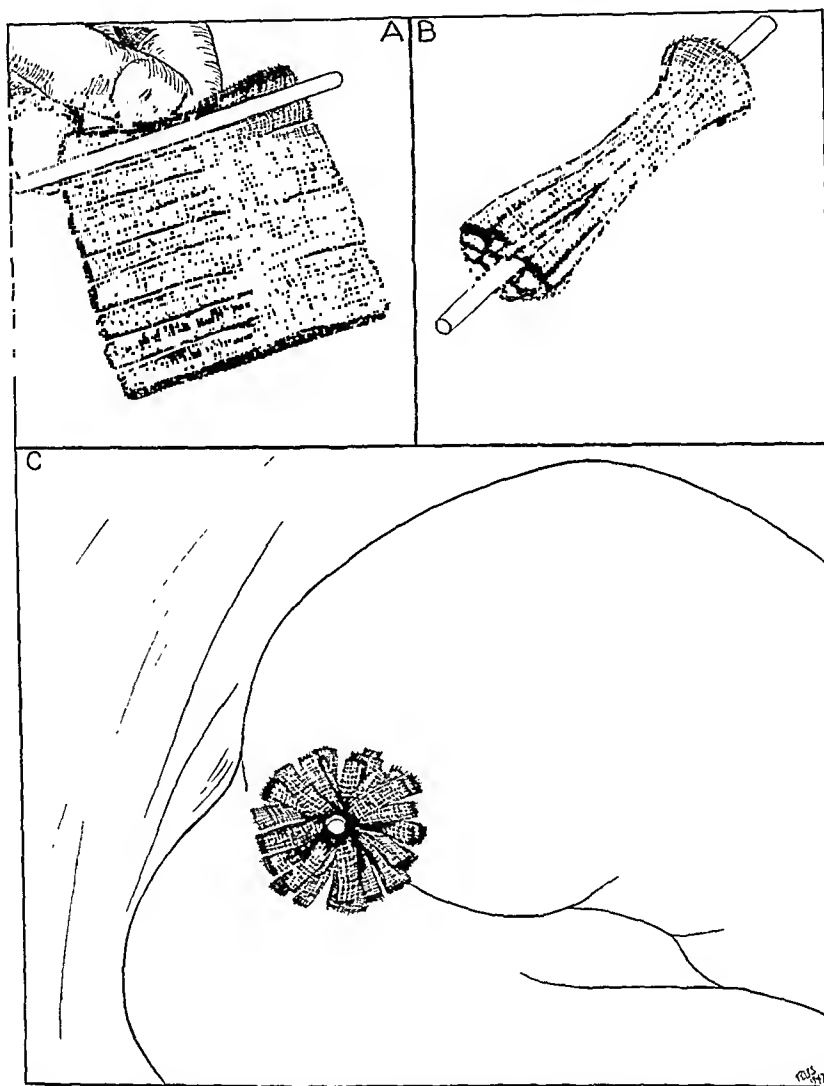
FIG. 1. A, illustrating the method of cutting the oxycel strip; B, oxycel "whistle"; C, oxycel whistle dressing in place. The patient is in a left Sims position.

METHOD OF USE

In minor anorectal surgery we have used oxycel in one of three ways, namely, (1) alone; (2) oxycel wrapped around a small piece of gauze inserted as a dressing; (3) an oxycel "whistle" made by wrapping the oxycel around a No. 12F. hard rubber catheter approximately 4 inches in length.

as this allows the patient to expel gas, the retention of which has been a source of discomfort to some patients. This small oxycel "whistle" is inserted at the conclusion of the operation and because of its small size does not act as a foreign body and produce painful postoperative sphincter spasm. Oxycel fibers are spread

out in a radial fashion to cover the open incisions as illustrated. (Fig. 1.) A small piece of gauze is placed over the surface of this, the outer dressings are applied and the patient is returned to his room with the dressing in place. Postoperatively, no active effort is made to remove or withdraw the oxycel dressing. It dislodges itself spontaneously in one of the first few Sitz baths taken by the patient on the first or second postoperative day. However, if one desires, the small rubber tube may be removed without discomfort the next morning and the patient can take a Sitz bath an hour or two after its removal. In many cases it is not necessary to remove this catheter the first postoperative morning unless one wishes to relieve the patient of any anxiety regarding the condition of his recent operative site. By inspecting the wound, the patient can be given assurance that everything is progressing satisfactorily.

COMMENT

We have been impressed by the superior hemostatic effect exerted by the oxycel dressing upon venous and capillary oozing. Postoperative hemorrhage was not encountered in this series of cases either in a delayed form or from small capillary oozing at the site of the surgical incisions. Secondary hemorrhage due to the removal of gauze or rubber tissue drains is eliminated by the use of oxycel and the mental comfort of the patient is thereby enhanced. It is also of interest to note that during the postoperative period before the oxycel was expelled or removed the patient did not have any feeling of a foreign body within the anorectal canal. Therefore, we believe that there is less sphincter spasm and probably less reflex urinary retention in this series of cases. It is also to be noted that the majority of patients expelled the oxycel dressing in the Sitz bath or in the toilet the first or second postoperative day. Following the expulsion of the oxycel we noted that our incisions

tended to progress in a normal and satisfactory manner.

Although some retardation of epithelialization has been observed in cases in which oxycel has been left *in situ* for a prolonged time, this is not true here as the oxycel is removed within twenty-four to thirty-six hours.

Oxycel is not recommended for a surface dressing of open wounds except for hemostasis and, therefore, it should be removed when this purpose has been fulfilled. It has also been of considerable importance to us to note that in using mucous membrane as a modified graft overlying the suture line following repair of the sphincter there has been no distortion or displacement of the graft by the oxycel. The graft is not disturbed whatsoever when the oxycel is removed or expelled.

I would like to point out also that oxycel should not be left in an infected or potentially infected incison or wound in the anorectal areas as, in all probability, it will act as a media for continued suppuration and delayed healing. This should be particularly true of all deep sinus tracts and fistulae and in cases where it is used as a hemostatic agent following removal of a pilonidal sinus by the open method. If the deep portion of a fistula wound is inspected the third or fourth day following operation and it is discovered that the oxycel is not completely removed, it would be wise to flush this out with saline at that time. If we fail to remove the oxycel in these infected wounds, we can anticipate an undesirable effect from the retained oxycel as a continued source of suppuration.

CONCLUSIONS

1. Oxycel has been used as an effective hemostatic agent in a series of 478 cases of minor anorectal surgery.

2. Oxycel is not a substitute for careful surgical technic but rather an adjunct to it.

3. Oxycel finds its greatest use in controlling the venous and capillary oozing associated with wounds of the anorectal canal.

4. Oxycel gives rise to a minimum tissue reaction. It is relatively non-irritating, does not delay healing in any fashion and in all cases used it was expelled without any untoward reaction on the part of the patient.

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Roddenberry and Muzzato tried out the value of tyrothricin in the form of local applications to recently operated patients with infected pilonidal cysts (cysts excised). The raw postoperative area was packed daily with a fine gauze mesh soaked in 1: 5,000 tyrothricin. This was supplemented by local irrigations of this solution every four hours. Results were highly satisfactory and proved this to be the most effective therapy. Local therapy with penicillin was the next most effective treatment. Tyrothricin caused disappearance of all the various mixed organisms that usually contaminated such wounds, with the sole exception of Bacillus proteus. Surgeons should be more careful with the postoperative treatment of patients after total excision of the pilonidal cyst. I have had cases in which infection refused to heal for six to ten weeks or which even recurred. I am sure that had I thought of using tyrothricin in these cases, convalescence would have been greatly shortened and fewer patients would require re-operation because of the severe postoperative infection present. Let us not forget tyrothricin as an important topical antibiotic.

(*Richard A. Leonardo, M.D.*)

THYROID SURGERY*

POSTOPERATIVE PROBLEMS AND COMPLICATIONS

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SUCCESSFUL surgery of the thyroid gland is dependent primarily upon proper preoperative preparation. It is necessary to have had careful coordination between the internist, the anesthesiologist and the surgeon. During early thyroid surgery it was not uncommon to have a mortality rate from 40 to 50 per cent. This was due primarily to hemorrhage and sepsis. We have seen a gradual decline from this prohibitive rate down to 1 of under 1 per cent. In order to obtain such a low mortality rate it is necessary to give attention to every detail, especially the prevention of any complications. One must allow enough time to elapse between the first contact with the patient and the time of surgery so that toxicity may be almost completely controlled.

The subject falls naturally into three divisions: first, preoperative; second, operative; and third, postoperative. These aspects will be discussed in chronologic order.

It is not the purpose of this paper to discuss all the relative merits of Lugol's solution as compared with thiouracil or propylthiouracil. There are strong advocates for all. There are also those who thoroughly condemn the use of thiouracil; for example, Dragstead[1] believes the drug to be too dangerous for routine use in preparation of the goiter patient and does not allow its use on his service at the University of Chicago. To quote: "I believe the drug thiouracil is more hazardous than surgery."

According to Van Winkle et al.[2] the reasons for the dislike of thiouracil are evident in this table of side-effects among 5,745 patients receiving the drug.

TABLE I

TOTAL INCIDENCE OF SIDE EFFECTS OF THIOURACIL

	Per Cent
1. Leukopenia (white count below 4,000 with normal cell distribution)	4.4
2. Agranulocytosis or granulocytopenia (total count below 4,000, with relatively greater disappearance of granulocytes, plus fever and pharyngitis)	2.9
3. Drug fever	2.7
4. Skin eruption	3.3
5. Less frequent complications: (nausea, dizziness, headache, abdominal cramps, parotitis, joint pains, jaundice, diarrhea, and edema)	
Total incidence	13.3%

Payne[3] called attention to the possible development of malignancies in toxic diffuse goiters by the use of thiouracil.

Propylthiouracil seems to carry a lower incidence of complications and side effects. However, Lahey[4] reported "untoward effects in 2% of 300 patients where this drug was used in preoperative preparation." He reported one case of drug fever and five cases of white cell depression. One of these cases progressed to agranulocytosis.

Recently Eisenmenger[5] reported a case of leukopenia that developed after thiouracil therapy. Propylthiouracil was then substituted and severe leukopenia again developed. The patient was then successfully prepared with Lugol's solution.

Livingston[6] reported a case of agranulocytosis followed by hepatocellular jaundice after the use of propylthiouracil.

It is evident from this that while propylthiouracil is a definite improvement over thiouracil, it still is a dangerous drug to use in preoperative preparation. The blood counts of all patients who are using propylthiouracil should be checked frequently for

leukopenia in order that agranulocytosis does not develop.

It has been my experience that however toxic a patient may be, he can be successfully prepared by the careful use of Lugol's solution unless he is a member of a small group of patients who do not respond well to iodine. These patients can be prepared with either propylthiouracil or thiouracil.

No matter what drug is used certain criteria must be fulfilled. First, the patient must show a satisfactory gain in weight. Second, there should be a gradual drop in the pulse rate. The pulse rate should be under 110 and preferably below 100 for several succeeding days before surgery. Third, there should be a lowered basal metabolic rate. Fourth, the appearance of toxicity should have disappeared to a very large degree.

It usually takes from two to five weeks to accomplish the criteria desired. This time element may be considerably lessened if one cares to use sodium iodide intravenously. It is not uncommon to see the pulse rate and the well being of the patient greatly improved by the use of sodium iodide intravenously in from three to seven days. I have used sodium iodide intravenously only in those patients who were seriously ill from toxicity and have found very encouraging results. However, one must not disregard the time element of from two to five weeks' preparation even though the patient's pulse and condition has improved tremendously after the intravenous injections of the drug.

OPERATIVE COMPLICATIONS

Hemorrhage. Hemorrhage is one of the most common and one of the most serious complications of thyroid surgery. The rich blood supply of the normal thyroid gland plus the greatly increased blood supply of the toxic diffuse goiter and the large vessels overlying and about the adenomas make hemorrhage always a grave possibility.

Hemorrhage during the operation can be combated by the use of intravenous fluids, plasma and even transfusions if necessary. However, gentle handling of the gland and careful securing of the vessels will prevent serious hemorrhage.

Hemorrhage occurring postoperatively is potentially very dangerous. The clot producing pressure on the trachea may make life very short unless this is relieved immediately. It is well to open the wound in the room and evacuate the clot before the patient is returned to surgery. After the patient is returned to surgery the clot can be fully removed and the bleeding point secured. In the patients operated upon at Good Samaritan Hospital during the past two years there was one postoperative hemorrhage occurring on the second postoperative day. The surgeon took this patient back to surgery.

Usually bleeding has occurred from either the superior or inferior thyroid artery after a tie has slipped off. It is my belief that the superior thyroid artery should be transfixed and ligated with an atraumatic needle at the time of surgery. The inferior artery should be divided far enough away from the capsule so that it can be tied well.

To prevent hemorrhage further, the remnants of the gland on each side of the trachea can be sewed with a running catgut stitch. This will cover over the raw surfaces and prevent further oozing. It is well to allow the patient to awaken before closing the strap muscles. He then will strain and cough and, if there are any collapsed vessels, they will readily be found at this time.

Hemorrhage under the flap is never serious. A small localized hematoma may be left alone. If there is much hemorrhage under the flap, it is best to take the patient back to the operating room, clean out the blood and tie the bleeding vein. Otherwise the scar will be unsatisfactory in appearance.

Hole in the Trachea. Hole in the trachea may occur accidentally at any time but is more likely to occur at secondary operations or in malignancies when the gland is very adherent to the trachea. If this

accident occurs, the anesthesia can be deepened while the hole is closed. It should never be a serious complication although infection may develop. For this reason a drain should always be inserted.

Hole in the Pleura. A complication which may occur is opening the pleura

DIFFUSE TOXIC

FIG. 1. Showing thyroid crisis with abrupt rise in temperature and pulse rate. There was an abrupt fall of the temperature and pulse following use of sodium iodide and glucose intravenously.

when removing a substernal adenoma. The pleura is frequently attached to the adenoma and it is necessary to slide the pleura off carefully before a hole is made.

Crisis. Formerly many patients died from thyroid crisis. Today this condition is seldom seen and then only in those unfortunate patients who have been carried on Lugol's, thiouracil or propylthiouracil over a long period in an attempt to cure the hyperthyroidism by the administration of drugs. With careful and more prolonged preparation of the thyroid patient, postoperative crisis has fallen off markedly. It still may occur.

Prevention by judicious and prolonged preoperative treatment is most important in preventing crisis. Bed rest, a high caloric diet of from 4,000 to 5,000 calories per day,

high fluid intake and the proper amount of rest are all important preventive measures. Rest may be secured through the use of sedatives. Phenobarbital (gr. 1½) at night and tincture of opium (15 m.) two or three times a day, usually will secure the necessary amount of rest. Compound solution of iodine is, in my opinion, the treatment of choice. This is usually given by mouth except in the very severe case when intravenous sodium iodide is helpful. Intravenous glucose may be necessary and should be given once or twice a day unless the fluid intake is adequate.

In this series of 100 cases there was one postoperative crisis:

CASE I. This sixty-three year old woman had been placed in the hospital under the care of an internist. (Fig. 1.) She was brought under control by the use of Lugol's solution and then allowed to return home. After three months she was returned to the hospital markedly nervous with a high basal metabolism rate and a high pulse rate.

After what was considered proper premedication, I operated on her with no unusual difficulty. Her postoperative course was normal and mild until 8 P.M. the second day. Her pulse rate increased from 90 to 160 and her temperature rose from 100 to 160°F. The patient developed a severe crisis. She was given intravenous glucose supplemented by sodium iodide several times. After about two hours the crisis abated. The illustration shows the rapid rise in temperature and pulse rate once the patient's crisis was under way, and also the rapid drop in temperature and pulse rate after the sodium iodide and intravenous glucose had time to get in their work. This patient has been well for the past four years.

CASE II. This twenty-one year old woman had been operated on for a very toxic diffuse goiter at the age of thirteen years. She was extremely toxic during her presurgery hospitalization. The internist prepared her for six weeks with thiouracil and then for two weeks with Lugol's solution.

Following surgery the rise in temperature to 102½°C. can be seen on her first postoperative day and the rise in pulse rate to 145. (Fig. 2.) She was given not only 100 drops of Lugol's solution the day of surgery but also

31 gr. of sodium iodide. This was repeated twice daily until the fifth day. Her toxicity, manifested by the increased temperature and pulse rate, at that time began to drop and steadily fell to about normal on the sixth day.

CASE III. This twenty-three year old woman entered the hospital after having been given

pounds down to about 95 pounds. At the time she entered the hospital she was unable to retain food because of nausea and vomiting. She was placed on 10 m. Lugol's solution three times a day and also, for two days, 31 gr. sodium iodide given intravenously once daily. Nausea and vomiting stopped within forty-eight hours.
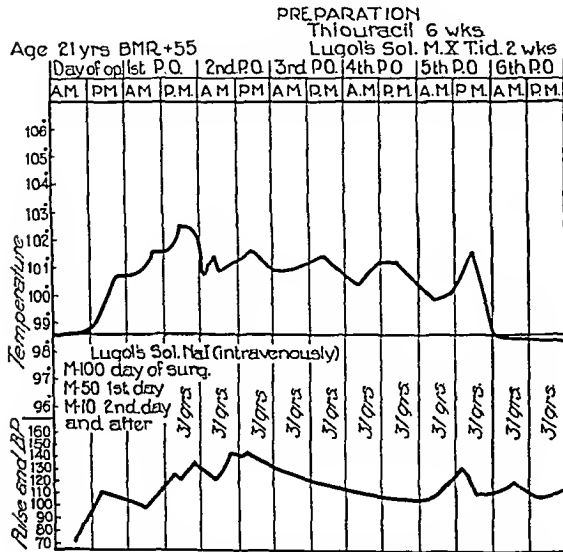
FIG. 2. Postoperative toxicity in recurrent diffuse goiter controlled by use of sodium iodide and intravenous glucose.
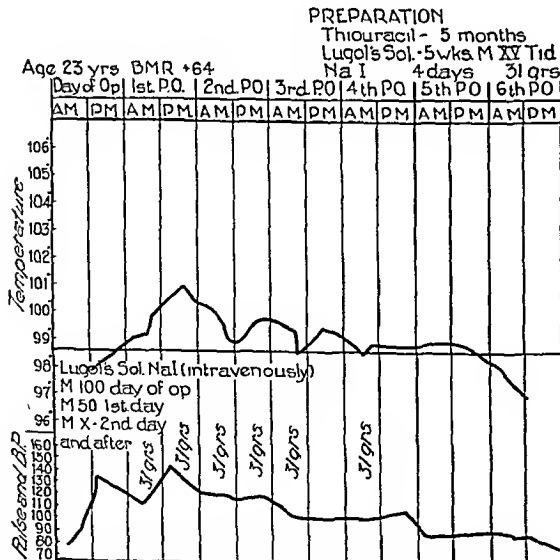
FIG. 3. Mild postoperative reaction in diffuse toxic goiter following use of sodium iodide and intravenous glucose.

FIG. 4. Nodular goiter treated with sodium iodide and glucose postoperatively.

After a period of preparation she was operated upon and one can see by the graph (Fig. 3) that with the use of Lugol's and sodium iodide twice daily she made an uneventful recovery.

CASE IV. This forty-six year old woman had a nodular, very toxic goiter and a basal metabolic rate of plus 60. She was prepared for two months with thiouracil, and with Lugol's solution, 10 m. three times a day for two weeks. It will be noted that following surgery with the use of sodium iodide and Lugol's solution her temperature rose only to 100°F. on the first postoperative day and her pulse rate was only 130. (Fig. 4.)

In comparing Figures 2 and 3 with Figure 1, one can see how much smoother convalescence these two patients made after the use of sodium iodide intravenously. A thyroid crisis could have developed in either of these patients and, in my opinion, would have occurred without intravenous sodium iodide.

There are certain factors which are very valuable in preventing crisis. First, intra-

thiouracil over a five-month period in the middle west. She had lost in weight from 125

venous glucose, given both pre and post-operatively is very important. All toxic patients receive 1 to 4 Gm. of sodium iodide per day depending upon the amount of toxicity, pulse rate and appearance. If their toxicity is severe, they are placed in an oxygen tent. This will make them much more comfortable, often dropping their temperature from one to three degrees. They may be left in the tent for a few hours or a few days if necessary. Aspirin is given by mouth or by rectum in cases of pending or actual crisis. This will promote sweating and consequently a desirable fall in temperature. Lugol's solution given post-operatively is valuable and is given in 30 to 100 m. per rectum the first day, then 5 m. daily for three months more. This will help to prevent the thyroid remnents from hypertrophying.

One-sixth gr. of morphine is used for rest during the first few hours after surgery. After this 1 gr. of codeine sulfate and 1½ gr. nembutal are used to secure relaxation and rest. If morphine is continued over any great length of time, it may prolong any nausea and vomiting.

Recurrent Laryngeal Paralysis. Recurrent laryngeal paralysis is the most distressing of all the complications. All patients should have their vocal cords studied by a competent otolaryngologist before thyroidectomy is carried out. In a study of a large series of presurgery cases it has been found that about 10 per cent have unilateral vocal cord disability. The pressure on the recurrent nerve has been so gradual that compensation has occurred rather easily and unnoticed. For several years Lahey[7] has dissected the nerves at the lower end of the gland. He believes this has prevented injury to the nerve. Pemberton[8] believes this is unnecessary as you see only the lower part of the nerves and that, as a rule, injury to the nerve is done near the superior pole. If one leaves a small amount of gland at the posterior capsule, the nerve is protected.

Injury to one nerve will leave that vocal cord powerless. One has two choices as to what to do. First, it can be left alone and usually will cause little trouble. This is undoubtedly the treatment of choice. There is always a temporary change in the voice. After a time the voice will recover somewhat although it never completely recovers its full range. Second, the neck can be re-opened and the nerve dissected to see if the nerve has been tied. If so, this can be remedied by simply cutting the suture. If the nerve has been divided, the ends can be resutured. Suturing of the nerve has not proven very satisfactory. However, most of the suturing has been done on old, fixed cords.

. In injury to both recurrent laryngeal nerves both the adductor and abductor muscles are paralyzed so both cords are in a flaccid position. There are four procedures which may be carried out: (1) Tracheotomy which is often a life saving procedure; (2) resection of one of the paralyzed cords as described by Hoover.[9] This gives the mucous membrane lines airways in the larynx but, as a rule, a very poor voice. (3) Brien King's[10] operation consists of disarticulating the arytenoid cartilage and displacing it outward in a position of outward rotation and attaching it to the border of the thyroid cartilage. Dr. King has performed this operation 101 times. (4) Heyd[11] reports thirty cases of vocal cord paralysis. He has shown that the great majority of vocal cord disabilities following thyroidectomy are due to traumatism and not due to severance. They have treated their patients with steady cathode galvanization over the nerve and interrupted muscle stimulation over the laryngeal muscles on the affected side with which ever current is needed for a good contraction of the vocal cords. If the original examination shows that some faradic response is preserved, the outlook is excellent and restoration within three months can be expected.

Tetany. Tetany is a very infrequent complication. This usually occurs in secondary operation. It is due to the fact that two or three of the parathyroid glands often have been removed at previous operations.

At secondary operations it is well to remember that this distressing complication may be prevented if one stays high on the lateral capsule. Every effort should be made to identify the parathyroids.

Dodson[12] reported eight out of twelve cases of thyroiditis which later developed tetany following thyroidectomy.

This complication manifests itself within a few hours to two or three weeks later. As a rule, it occurs on the second or third postoperative day. The diagnosis is easily made by the carpopedal spasm or the patient may have an outright convulsion. Trousseau's and Chvostek's signs make the diagnosis when they are positive. Examination of the blood calcium will show it to be low. If there is any indication of parathyroid injury, treatment should be started early.

The best treatment is parathyroid extract followed by 5 to 10 cc. of 10 per cent solution of calcium chloride intravenously. If the tetany persists, 60 to 120 gr. of calcium lactate should be given every day along with cod liver oil. In the more difficult cases to control Pemberton and Stalker[13] believe that di-hydro-tachysteral (A.T. 10) along with calcium lactate is the best treatment. Vitamin D concentrate in doses of 50,000 to 150,000 units will also help the control if true tetany continues. Repeated blood calcium studies should be made.

As a rule these cases improve and frequently attacks will disappear entirely after a time. They often are completely relieved before the patient leaves the hospital as they are due to temporary interference with the blood supply or to edema.

Cardiac Disabilities. In elderly patients cardiac decompensation may be observed before and following surgery. These patients should be under the care of an able internist for a considerable length of time before coming to surgery. The standard measures, such as digitalis if necessary, should be fully employed.

Auricular fibrillation is a frequent complication especially in the nodular goiter patients. It rarely appears postoperatively in patients under forty years of age. This complication may be present before surgery is done or it may manifest itself following surgery. Quinidine and digitalis are the two stand-bys for those patients who show postoperative fibrillation. Many believe that quinidine should not be used until late in the postoperative period. It is their belief that the irregular rhythm will break of its own accord after the goiter is removed. Quinidine, however, carefully employed will usually break the rhythm back to normal.

Minor Complaints. Annoying cough and distressing mucus may be relieved by inhalations of steam cough mixtures, high fluid intake and intravenous glucose in plain water. If the patient is unable to take large amounts of fluids by mouth, 5 per cent intravenous glucose is indicated in all these cases.

Postoperative pneumonia is a very rare complication in goiter surgery. A patient should not go to surgery until any cold or sore throat is completely relieved.

Wound Complications. Angulation of the skin wound resulting from drainage may be disturbing for a time. If the patient will pull down on the scar daily, it will soon loosen and the angulation will disappear. The scar never should be revised before one year has elapsed.

If the patient is a keloid former, this history should be ascertained before the goiter operation. The scar should be treated early with x-ray. Patients who present themselves with keloid formations one year or so later, should have the scar removed and a very careful proximation made. Immediately following surgery, that is a few days later, x-ray therapy should be given to prevent any further keloid formation.

Serum in amounts from small to large is quite common especially after using catgut for ties. For several years I have used No. 40 to 80 cotton for ties with splendid results. Many of these patients will heal without any drainage. A few patients will

drain a small amount of serum for a number of days.

Infection very seldom complicates thyroid surgery. Hot sterile compresses will clear up the wound in a short time.

SUMMARY

1. Proper preoperative care will avoid one of the most serious postoperative complications, namely postoperative crisis.

2. Careful, gentle surgery will prevent hemorrhage and injury to recurrent nerves or parathyroid glands.

3. The problems following thyroid surgery are usually easily handled by diligent postoperative management.

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CHRONIC ULCERATIVE COLITIS AND ASSOCIATED CARCINOMA*

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CHRONIC ulcerative colitis is a serious malady of which the exact etiology is not known and treatment is not of a precisely successful form. Fundamentally, it is a disease of youth with the peak of its age occurrence in the second, third and fourth decades. It is a chronically debilitating disease requiring long periods of hospitalization in its treatment and, save for the exceptional cases, reduces the patient to the status of semi-invalidism for the greater part of his remaining years.

Superimposed upon this picture of a disease are the serious complications which this disease is particularly apt to develop in its course of remissions and exacerbations: general debilitation, strictures, perforations, complete obstruction, polyposis and peritonitis. One of the less common complications encountered is that of carcinoma arising in the involved inflammatory area.

Bargen, Cromar and Dixon[1] discussed some very interesting findings which they believed were important in the relation between subclinical or clinical infections and early carcinoma in the large bowel. Minor inflammatory changes in the lymph follicles of the submucosa as evidenced by the so-called encapsulation or germinal center development in the follicles were the predisposing factor. These follicles by progressive enlargement ultimately rupture, allowing the epithelium to prolapse. Latta[2] has shown that epithelial cells in contact with lymphoid cells retain primitive characteristics. These epithelial cells may escape or be isolated in the loose connective tissue of the submucosa. A ring of follicle formation and contraction may produce the often noted flat adenomas. Hadfield[3] notes that large follicles are frequently seen in inflammatory lesions and the earliest changes consist of follicular enlargement and giant cell presence. So it is safe to assume that a potentially malignant region exists in the colon prior to and coincident with the development of carcinoma. Since the reactive change to inflammation is primarily in the mesoblastic tissue, the epithelial changes must be of a retrogressive nature unless full function and histology returns, a condition little apt to occur when extensive damage has been done as in chronic ulcerative colitis.

Brust and Bargen[4] suggest that the pathologic condition of this disease is such that as the small abscesses rupture there is a slough of the overlying mucosa, leaving relatively normal marginal mucosa which is piled up as pseudoprojections or pseudopolyps. The healing process proper may take either of two courses: true healing may occur with resultant pock-marked mucosa, thickening and contraction of the wall of the colon or complications may result with the formation of strictures, polypoid masses, adenomatous polyps and carcinoma. True adenomas may develop in the very late stage of healing, but this is a very rare occurrence. Frequently, the tips of these adenomas show poorly controlled growth with retention of secretions and collections of débris, "colitis polyposis cystica." These authors make an interesting deduction from their figures, showing an incidence that 2.5 per cent of 800 patients with chronic ulcerative colitis develop carcinoma. The United States Department of Commerce (1923 to 1929)

states that 0.011 per cent of all the population die of carcinoma of the large bowel and rectum. This comparison certainly indicates the presence of a carcinogenic factor in chronic ulcerative colitis.

The malignancy which develops may be either of two general types: localized polypoid carcinoma or the diffuse carcinomatous involvement of almost the entire inflamed area. Irrespective of the type or location of the malignant process, it is well agreed by most observers that the prognosis is universally grave. Hurst,[5] alone, finds the general prognosis in ulcerative colitis to be not too alarming. He reports eighty-five cases of this disease without an observed incidence of carcinoma as a complication, with 77.6 per cent of the patients well and an additional 10.6 per cent not well but able to carry on their usual activity. David, Rankin, Bargen, Coffey and Dixon[6-11] are greatly impressed by the serious prognosis of the malignancy where it develops and uniformly urge a radical form of treatment. Bargen and Dixon[10] report twenty-seven cases of carcinoma complicating chronic ulcerative colitis. Four of the twenty-seven patients had diffuse carcinomatous involvement of the entire colitis area; five of the twenty-seven had multiple primaries. From their presented data it is possible to conclude that seven died in the period of initial operative treatment. A total of seventeen died altogether. These authors, as well as Rankin[7] and David,[6] advise excision of the entire colitis area in treatment of the malignancy. This is well established reasoning for in a report by Bargen[9] of 200 late chronic ulcerative colitis patients 13 per cent showed polyp or pseudopolyp formation. In this same series were twenty patients with the complication of carcinoma, of whom fifteen were operated upon and twelve died, seven of generalized peritonitis.

There seems to be general agreement among observers that polyp formation occurs with greatest frequency at the site of severest inflammation. The transition features a progression from inflammatory polyps to adenomatous polyps to carcinoma. The classification suggested by various authors[8,11] seems a very useful one and is based on clinicopathologic evidence: (1) Congenital adenomatosis (no relation to chronic ulcerative colitis). (2) Chronic ulcerative colitis with polyposis (pseudo-adenomatous polyps; adenomatous polyps which are very rare and similar to adenomas of multiple polyposis and carcinomatous polyps).

Coffey and Bargen[8] found the following incidence of the various types of polyps according to the classification just given. All the cases with polyp formation were classified:

	Multiple Adenomatosis (Per cent)	Chronic Ulcerative Colitis with Polyposis (Per cent)
Pseudo-adenomatous.....	....	56.2
Adenomatous polyps.....	100	21.9
Carcinomatous polyps....	62.5	21.9

Coffey[11] states that the incidence of pseudopolyposis in chronic ulcerative colitis is 10 per cent. Malignancy in chronic ulcerative colitis is 2.5 per cent and in 60 per cent of these cases of malignancy polyps were found.

Cabot case No. 25201[12] presents the usual history but the unusual feature was the roentgenographic picture which showed a normal rectum and transverse colon. The involved areas were the cecum, ascending colon, splenic flexure and descendens down to the rectosigmoid. The usual pseudopolyps were seen and an unusual type of plateau polyp. The treatment consisted of an *ileosigmoidostomy* with survival and great improvement.

Cabot case No. 19023[13] is of interest. The patient's age was fifty-nine years. The history was one of a low grade chronic ulcerative colitis for nearly the entire life of the patient. Roentgenogram of the colon

revealed multiple polyps throughout the colon and an ileostomy and total colectomy were done. The particular interest of this case was the pathologic examination of the surgical material. The findings of chronic ulcerative colitis were present; two types of polyp formation were found, consisting of adenomatous polyps with many areas borderline between adenoma and carcinoma and the other type of inflamed granulation tissue and pseudo-adenomatous polyps. In addition there was an almost complete sigmoid stricture on an inflammatory basis.

Matzner and Schaefer[14] report a case of a patient aged twenty-nine years who had been under treatment for chronic ulcerative colitis for seven years. There was a sudden change of symptoms, consisting of a mass in the abdomen, rapid progressive weight loss and a decrease in the number of daily bowel movements. The diagnosis was obstructing polypoid sigmoid carcinoma and far advanced chronic ulcerative colitis with polyposis. These same authors present their statistics over a twenty-year period in comparison with those of the Mayo Clinic. These will be shown at the end of this paper, with the additional cases from the University Hospital, Ann Arbor, Mich.

In a twelve-year registration period at the University of Michigan Hospital three patients with carcinoma complicating chronic ulcerative colitis were treated. This may not be a true picture since other patients with chronic ulcerative colitis may have developed malignancy with no information given to this institution. One case (Case 1) is so typical a course of the complicating disease that the case record is presented in some detail in connection with x-rays and pathologic tissue studies.

CASE REPORTS

CASE 1. E. L., Hospital No. 370896, aged twenty-one, was a white female. The original hospital admission was on October 22, 1935, with a history of diarrhea of eight years' duration, with stools eight to ten times per day. For

FIG. 1. Case 1, biopsy specimen obtained at the time of the first hospital admission which revealed typical findings of chronic ulcerative colitis.

the past two years the stools consisted of blood and mucus. The past year had resulted in a 20-pound weight loss.

The past history and systemic review were non-contributory except for two previous abdominal operations for a uterine tumor and a lysis of adhesions. Menstrual history gave the onset to be at seventeen years of age with periods occurring one to two times a year until nineteen years of age; then they were normal until two months prior to admittance to this hospital. At the time of admittance her periods occurred every two weeks with a four-day duration.

Physical examination was remarkably good with no evidence of a chronic debilitating disease.

Rectal and sigmoidoscopic examinations revealed numerous ulcerated areas in the lower colon with many bleeding points. The mucous membrane was covered with a grayish membrane which, when removed, left bleeding areas. There were many small granulating ulcers. Biopsy specimen confirmed the diagnosis (Fig. 1) of chronic ulcerative colitis. Barium enema studies (Fig. 2) showed typical findings of chronic ulcerative colitis with some involvement of the terminal ileum. Basal

FIG. 2. Barium enema air injection studies at the time of the first admission revealing typical roentgeno-graphic evidence of chronic ulcerative colitis, with some involvement of the terminal ileum.

FIG. 3. Biopsy taken at the time of a check-up on March 16, 1939, showing medullary adenocarcinoma, grade III, infiltrating in the smooth muscle, adipose and connective tissue.

metabolic rate was −18 per cent, with a pulse rate of 64. Complete stool studies revealed no specific pathogens. Hemoglobin was 80 per cent (Sahli).

The patient was treated actively on the medical service with no resultant improvement; surgical care was advised. During the period of medical management the patient ran a particularly febrile course. On December 18, 1935, an ileostomy was done. Aside from a rather severe wound infection, the postoperative course was quite uneventful; she was discharged on February 15, 1936.

She returned January 13, 1937, with no complaints; there was a weight gain of 10 pounds as well as a re-establishment of the normal menses with thyroid medication and resumption of her own housework. There was no stool or discharge from the rectum. The possibility of re-establishing the intestinal continuity at this time was considered. Sigmoidoscopic examination revealed no active ulcerations; the papillae were reddened and the mucosa injected. Barium enema revealed a very small ampulla. The entire colon was leadpencil in size and filled almost instantly. The opinion was that continuity could not be

resumed at this time and she was discharged January 29, 1937.

The patient was repeatedly seen in the out-patient clinic where she appeared to be doing well. Barium enemas on June 2, 1937 and January 12, 1938 showed progressive colon narrowing and loss of haustration. Sigmoidoscopy on this latter date revealed a stricture at 9 cm. beyond which the scope could not be passed, but no malignancy appeared in the mucosa.

The patient returned March 16, 1939, stating that she had had no weight loss and felt very well. She had had the onset of a rectal discharge of blood and mucus in July, 1938. Sigmoidoscopy revealed the previously described constriction; the overlying rectal mucosa was ulcerated, red and granular with polypoid changes. A biopsy was reported as medullary adenocarcinoma, ' grade III, infiltrating in smooth muscle, adipose and connective tissue and extending along lymphatic channels in adipose tissue. (Fig. 3.) Barium enema revealed advanced chronic ulcerative colitis with minimal evidence of associated polyposis.

The patient was admitted and prepared for operation. On April 24, 1939, a one-stage combined abdominal perineal resection of the rectum, with a bilateral salpingo-oophorectomy was done. At the time of operation no gross metastases were found although there were many enlarged nodes in the relatively short mesosigmoid. Pathologic examination revealed a 30 cm. segment of large bowel which was markedly contracted and hose-like in appearance. Microscopic examination (Figs. 4A to D)
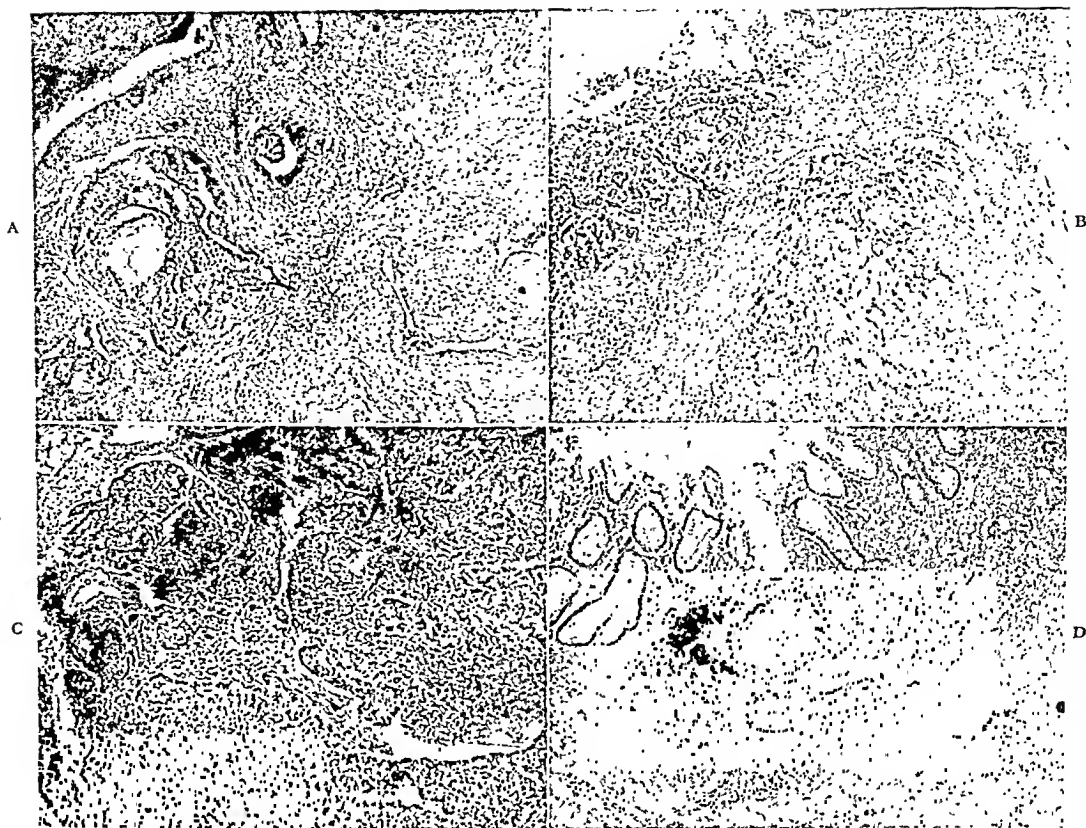
FIG. 4. A, specimen obtained at the time of operation showing extensive infiltrations of adeno-carcinoma occurring in the large and small nests of the ovaries. B, Surgical specimen showing carcinomatous infiltrations in the Fallopian tubes. C, surgical specimen of an isolated lymph node showing extensive replacement by neoplastic tissue. D, section taken from the upper end of the resected large bowel showing extensive infiltrative metastases at the line of resection.

revealed extensive infiltrations of an adeno-carcinoma, occurring in large and small nests in the ovaries. The Fallopian tubes showed carcinomatous infiltration. There was an adenocarcinoma, grade III, primary in the colon. Serial blocks taken along the length of the specimen showed widespread adenocarcinoma in the upper five-sixths.

In the lower remaining portion of the rectum there were changes of chronic ulcerative colitis with polyposis and carcinomatous invasion in a few of the lymphatics. Of one hundred lymph nodes isolated by the technic previously described by Coller, Kay and MacIntyre[15] seventy were largely replaced by carcinoma. The patient's postoperative course was uneventful and she was discharged on May 28, 1939.

On July 31, 1939, she returned because of severe pain in her lower back and right flank. X-ray examination of the spine revealed osteoclastic metasases in the right margin of the second lumbar vertebra. Palliative x-ray

therapy was given and repeated on a re-admission on September 19, 1939. The patient went into shock on September 28, 1939, and remained so until death occurred two days later.

The autopsy examination was limited to the abdomen. The pathologic diagnoses were: sub-acute fibrinopurulent peritonitis, hydroperi-toneum, metastatic carcinoma in the transverse colon, hepatic flexure, liver, spleen, adrenals, periportal, peripancreatic and inguinal nodes. There also was peritoneal carcinomatosis and metastatic carcinoma in the lumbar vertebral bodies. (Figs. 5A to C.)

CASE II. S. J. B., Hospital No. 473192, aged forty-seven, was a white male. There was a history of onset of dyspepsia, mild cramps and nervousness six months prior to admittance. Five to six weeks prior to admittance there was an episode of acute "intestinal flu," with four to five bowel movements a day, generalized abdominal cramps, distention and liquid stools; there was no melena. Subsequently, there was an alternating diarrhea and
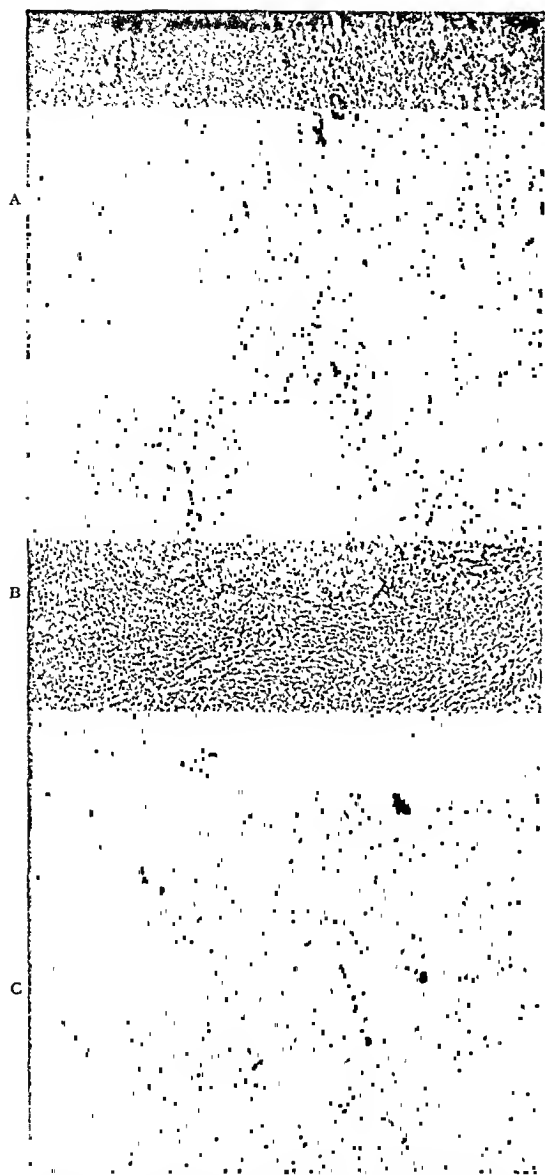
FIG. 5. A, autopsy specimen showing anemic infarction of the adrenal with neoplastic cell nests in the zona fascieulata. B, autopsy specimen showing large and small metastases and secondary degenerative changes in the liver. C, autopsy specimen showing the spleen with subaeute peritonitis and metastatic neoplasm in the parenchyma.

constipation, changing every three to four days. Four weeks before a gastrointestinal x-ray and protoscopic examination done elsewhere were reported to be negative.

Physical examination revealed a pneumonic process of the right base. Abdominal examination showed distention but no masses or tenderness. X-ray and cholecystogram examinations showed a normal upper gastrointestinal tract.

There was marked distention of the large bowel down to the sigmoid. Stool examination was positive for occult blood; white blood cells were 13,700 and hemoglobin was 70 per cent. The plasma chlorides were 459 mg. per cent and the non-protein nitrogen was 58.8 mg. per cent. An emergency cecostomy was done as a palliative measure but the patient succumbed.

Pathologic examination revealed an extremely severe process; the abdomen was distended and tympanitic, with an escape of gas upon opening; there was generalized peritonitis adherent at the sigmoid. The colon showed marked dilatation, discoloration and gangrene, with numerous areas of perforation in the transversus. Numerous transverse punched out ulcerations of the transverse colon were seen when it was opened. Ascendens and sigmoid were normal grossly. Distal to the ulcerations in the transverse colon was a 4 by 3 by 3 cm. intraluminal polypoid lesion with partial obstruction.

Microscopic examination revealed a necrotizing ulcerative colitis with gangreneous perforations. There was a slightly papilliferous adenocarcinoma, grade II.

CASE III. E. F. L., Hospital No. 267740, aged fifty, was a white male. There was the usual history of typical ulcerative colitis of moderate severity for ten years. Ten months prior to the present admittance there was an onset of progressive obstructive symptoms. A transverse colostomy was done at another hospital because of a sigmoid obstruction. At about the same time ·urinary frequency, urgency and dysuria occurred. In May, 1939 the patient experienced sudden abdominal pain and the passage of gas *per urethram*.

Physical examination revealed the patient to be in a state of emaciation. The only specific finding .was a hard, questionably extrarectal mass.

Roentgen examination revealed an obstructive lesion of the sigmoid. Cystoscopic examination revealed no fistulae or malignancy. Sigmoidoscopy showed no lesion of the mucosa but a definite mass was seen and felt as an encroachment on the lumen. Abdominal surgical exploration showed findings suggestive of chronic ulcerative colitis high in the midsigmoid and through the remainder of the sigmoid and rectum. No malignancy was seen.

The patient died on his fourth postoperative day of a pulmonary embolus.

Autopsy examination revealed right pulmonary infarction and typical findings of long-standing chronic ulcerative colitis. Beginning 12 cm. above the mucocutaneous junction and extending 14 cm. above that was a polypoid, ulcerating, hard lesion. The rectal wall was 3 cm. thick. There was numerous small "polypi," averaging 2 cm. proximal to the lesion. There were two perforations of the rectum into an abscess cavity of 200 cc. communicating with the bladder and sigmoid lumina.

Microscopic examination diagnosed an adenocarcinoma, grade II, of the rectum, bladder and adjacent tissue. It is interesting that the thickening of the rectal wall was both on an inflammatory and a neoplastic basis.

COMMENTS

Case III was of interest because of the three pathologic complications of chronic ulcerative colitis: polypoid degeneration, perforation and malignancy. All three of these cases present the typical history and findings of chronic ulcerative colitis, with a sudden change in symptoms which marked the onset undoubtedly of clinical malignancy although the irreparable damage was wrought at an earlier time. The 100 per cent mortality in this small number of cases only adds additional statistics to the already accepted fact of the almost uniformly grave prognosis in a case of ulcerative colitis in which neoplasm is added as a complication. Adding the information to the facts quoted by Matzner and Schaefer[14] the results are:

	Mayo Clinic	Jewish Hospital	University of Michigan
Total cases of ulcerative colitis..	800	185	451
Per cent of carcinoma in total cases of ulcerative colitis.....	2.5	1.6	0.7
Per cent of carcinoma of large intestine of all admissions.....	0.88	0.5	0.3

While there is considerable discrepancy in the incidence statistics, it must be

remembered that the cases of malignancy complicating chronic ulcerative colitis are relatively rare. It is noteworthy that in all three quotations just stated there is general agreement that carcinoma of the large bowel and rectum occurs approximately two to three times as frequently in patients with chronic ulcerative colitis as it does in a sampled unselected number of hospital admittances. This, again, only further augments the statement of Brust and Bargen[4] that there is a definite carcinogenic process present in chronic ulcerative colitis. This process must be assumed to be the inflammatory process fundamentally for from it arises the pseudopolyps or inflammatory polyps, the true adenomas or the metaplastic regenerating mucosal tissue which may become isolated deep in the reparative mesoblastic structure producing the described, diffusely infiltrating malignancy which is undistinguishable grossly from the mural thickening subsequent to healing in the disease.

The evident failure throughout all the literature of resection procedures for malignancy, leaving part of the diseased bowel, stresses the importance of complete removal of all the bowel involved in ulcerative colitis. This consideration undoubtedly will decrease the deaths from peritonitis and will avoid the presence of residual diffuse carcinoma in the remaining submucosa which is practically impossible to differentiate grossly from the late stages of chronic ulcerative colitis.

Patients with a history of chronic ulcerative colitis, even though progressing well on a medical regimen, must be repeatedly and carefully examined by barium enema and sigmoidoscopy for evidence of polyp formation. The rare case in which an ileosigmoidostomy or ileorectostomy is done since the lower colon was spared in the disease must be constantly considered a source of irremediable damage because of the mere presence of that section of large bowel. It even might be a safer procedure to consider a total colectomy in all cases of ileostomy for chronic ulcerative

colitis in which a rapid improvement in the rested colon has not occurred and that without polyp formation.

Constant vigilance is the rule in this disease, a disease which in its own course is debilitating and incapacitating with a significant mortality rate. To these facts is added the extremely serious circumstance that patients with this disease are two to three times as liable to develop a malignancy..

SUMMARY

A review of the literature on carcinoma complicating chronic ulcerative colitis is presented with the opinions and recommendations of many observers in respect to management and prognosis.

Three cases are presented somewhat in detail with illustrative x-rays and microscopic material.

A general discussion of the diseases is presented.

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MESENTERIC CYSTS

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THE occurrence of a mesenteric cyst was first recorded during the year 1507 when Beneviene, a Florentine anatomist, reported one observed at autopsy. Rokitansky's[1] description of a chylous cyst in 1842 is generally accepted to be the first accurately recorded case history. The most complete historical records made in recent times are the fifty-two cases described by Friend[2] in 1912. These cases were supplemented to ninety-five cases by Benedict[3] in 1913. In 1932 Warfield[4] had reviewed 129 cases and added two more, estimating that there were probably 500 cases recorded in medical literature. Parsons[5] in 1936 also estimated that about 500 cases had been reported. Keesey[6] in 1938 estimated 400, and Slocum[7] 300.

Much of the difference in estimates is due to the inaccurate description of a mesenteric cyst. The term includes too broad a field and sometimes includes other mesenteric tumors with cystic characteristics. Before Dowd's[8] classification (1900) scientific information lacked accurate description, and there is no way of knowing the number of solid versus cystic tumors. This is one reason for Slocum's low estimate. A true mesenteric cyst, according to Roller,[9] is between the leaves of the mesentery, excluding retroperitoneal cysts and any that should be classed as malignant tumors. One universal point of agreement is that the condition is very rare. Statistics from large hospitals are adequate proof of its low incidence.

The early cases were reported from autopsies. In 1880 a case was recorded to be a successful operation. It was not until this century that recognition of this condition and successful treatment were scientifically instituted.

ETIOLOGY AND CLASSIFICATION

Mesenteric cysts have been reported in individuals of every age from newborn infants to octogenarians; indications point toward greater frequency in early adulthood. The cysts are more prevalent in females than males. Friend collected data on fifty-two chylous cysts of the mesentery and found the occurrence covered all ages. The cysts varied all the way from 1 to 18 cm. in diameter. The usual location was in the umbilical region or between the umbilicus and pubes.

The etiology of these cysts is still obscure. In 1842 Rokitansky stated their origin to be from degenerated lymph nodes. Braquehaye[10] in 1892 and Moynihan[11] in 1897 classified mesenteric cysts according to their contents and suggested the etiology to be: (1) hemorrhage between mesenteric layers; (2) dilatation of lacteals or lymphatics; (3) degeneration of lymph glands. Noting the frequent occurrence in early childhood, Dowd in 1900 divided mesenteric cysts into classifications according to their origin: (1) embryonic (most common)—dermoid, serous, chylous, hemorrhagic, enteric; (2) hydatid; (3) cystic malignant disease.

Dowd substantiated this belief by tracing the embryology of the Wolffian body and the germinal epithelium aberrant identifying remnants which may become separated and carried into the mesentery and mesocolon there forming cysts. He also suggested that portions of the developing gut might likewise be displaced in the mesentery and later form an enterocyst.

Many writers since Dowd have amplified his classification and contributed additional theories as to the genesis of these cysts together with their own etiologic

classifications. Among these writers are Ayers[12] (1906), Niosi[13] (1907), Carter[14] (1921), Higgins and Lloyd[15] (1924), Ewing[16] (1928), Warfield[4] (1931), Snyder[17] (1938) and Roller[9] (1940). Of these Roller's is the most comprehensive while Snyder's seems the most practical. The following is Snyder's classification: (1) Simple cysts (containing clear serous fluid with or without lining membrane); (2) chylous cysts (similar to that just mentioned but containing chyle), (3) cystic dermoids and teratomas; (4) enterocystomas (containing muscular tissue and mucosa similar to the intestine); (5) parasitic cysts (hydatid or echinococcus).

It can be seen from the foregoing that there is no unanimity of opinion as to the genesis of these cysts or a satisfactory classification. Until further research brings to light the true etiology of these cysts, it is concluded that only those found between the leaves of the mesentery should be classified as true mesenteric cysts.

PATHOLOGY

Although most mesenteric cysts are single, they may be multilocular masses. Their sizes vary from those too small to palpate to those large enough to fill the abdomen. The most common site is in the mesentery of the jejunum or ilium, occasionally in the transverse mesocolon. The cysts lie between the leaves of the mesentery and are located anywhere between the enteric border to its base. They may be dumb-bell-shaped or spherical, depending on the projection of either mesenteric layer. Occasionally they surround the wall of the intestine, causing obstruction or strangulation of the adjoining loops. The cyst wall is usually thin and lined with epithelial cells. When the cyst is very large, the wall is so thinned by the pressure of its contents that its epithelial lining is lost and the wall is composed of fibrous tissue. Malignant degeneration is rare, and when it does occur it may be either carcinoma or sarcoma.

The contents may be chyle, serous fluid, clear or cloudy or blood.

SYMPTOMS AND DIAGNOSIS

Preoperative diagnosis of mesenteric cyst is still rare, partly because textbooks seldom mention the subject and also because there are no sure and indubitable pathognomic signs or symptoms. All writers agree that few mesenteric cysts will be diagnosed before operation.

The variance in size has already been mentioned. Two outstanding characteristics are the great mobility of the tumors in a transverse direction, and also the presence of intermittent pain of greater severity than is common with other abdominal cystic tumors. The pain is due to torsion, pressure and to a reduction in the caliber of the intestinal lumen. If the cyst is large, a fluid wave may be detected. Complications are usually present, including: intestinal obstruction; vomiting; alternate diarrhea and constipation; a change in weight, either an increase or decrease.[4]

Moynihan emphasizes that another factor in diagnosis is the presence of a zone of resonance around the cyst and a belt of resonance across it. Deaver[18] warns of the possibility of mistaking mesenteric for ovarian cysts. To avoid this he advises ascertaining if the tumor has grown from the abdomen toward the pelvis or vice versa, whether there is an inferior zone of resonance and whether both ovaries are independent of the tumor.

Mesenteric cysts should be considered in the differential diagnosis, the final diagnosis depending on elimination of other possible and more common conditions. These pathologic conditions should include: (1) retroperitoneal tumors; (2) ovarian cyst; (3) pancreatic cyst; (4) neoplasm of the bowel; (5) pedunculated fibroids of the uterus; (6) hydronephrosis; (7) movable kidney; (8) hydrops of the gallbladder; (9) omental cyst; (10) splenic tumor and (11) pregnancy.

Roentgenographic studies should be made in all cases in the process of exclu-

sion. X-ray can show the relationship of the tumor to the lumen of the bowel and the amount of narrowing from pressure.[14] An enema of barium sulfate can help in ruling out any involvement of the colon. Screening of the stomach may show a pressure defect. After barium palpation under a screen, with particular attention to the indentation and mobility of the viscera, is also helpful.[19] Pneumoperitoneum with screening or with the roentgenogram has been suggested by Flynn[20] for aid in determining the presence and location of the cyst.

TREATMENT

The treatment of mesenteric cyst is surgical. Enucleation is the procedure of choice whenever it can be carried out without serious impairment of the vascular supply to the bowel. When enucleation is not feasible, resection accompanied by removal of a portion of the bowel and anastomosis must be employed. This is often necessary in the presence of an acute intestinal obstruction with a gangrenous bowel. Marsupialization is obsolete, except in the very unusual case in which nothing else can be done. Aspiration is unsatisfactory as a means of treatment and has its place only to reduce the size of the cyst preparatory to removal.

PROGNOSIS

The diagnosis of this condition is usually not made preparatory to surgery and most surgeons in encountering it have never seen it before. Of the ninety-six patient's cases discussed by Benedict sixty recovered, fourteen died postoperatively, twelve were diagnosed at necropsy and results were not stated in the other ten. Infection is not a danger to be encountered in mesenteric cyst, but extensive adhesions or long-standing intestinal obstruction can be complications. Rupture of the cyst is a possible complication but a rare one as indicated by Eliason and North[21] when in 1935 they reported a case of ruptured mesenteric cyst which they believed to be

only the third such found at operation. Atchley[22] estimates the mortality of mesenteric cyst at 35 per cent, Warfield at 20 per cent.

CASE REPORT

M. J. D., a white female aged fifty-four, a secretary, was admitted to the Queen of Angels Hospital February 23, 1947, complaining of gradual loss of strength and a loss in weight of 15 pounds in six months. There was increasing constipation and intermittent colicky pain in the upper abdomen. Her appetite was poor and her digestion was fair; there was some nausea and vomiting; there was no blood or pus in the stools. The symptoms had begun about six months previously.

Her past history revealed a Cesarean section performed in 1919, a pan-hysterectomy performed in 1931 which had been diagnosed as fibromyomas uteri and in 1932 an appendectomy with resection of the terminal ilium; the cause was unknown. The patient had been under treatment for hypertensive heart disease for over five years.

The physical examination revealed the patient to be fairly well nourished; her facial expression and color were good. Examination was essentially negative except for the abdomen. A dimpled midline scar, 8 inches long, extended from the umbilicus to the symphysis pubis. Just above the umbilicus a round, firm, tender mass could be palpated. Upon physical examination, this mass was found to be movable and could be pushed from side to side or higher up in the abdomen.

Roentgenographic examination revealed a homogeneous density in the upper abdomen, 8 cm. in diameter, mobile and separate from the gallbladder, kidneys and gastrointestinal tract. Preoperative diagnosis was intra-abdominal tumor, probably mesenteric cyst. Omental cyst was excluded in the differential diagnosis due to the fact that the tumor could not be displaced downward.

On March 6, 1947, under spinal anesthesia, celiotomy was performed through a right rectus incision. A round, smooth cystic mass was located between the leaves of the mesentery 24 cm. distal to the ligament of Treitz. The tumor mass, although not a part of the bowel wall, was closely adjacent and involved its blood supply. The tumor was delivered, accurately packed and 24 cm. of jejunum and

FIG. 1. Gross specimen (author's case) showing actual size in cm., together with resected jejunum. Note close approximation to bowel wall.

FIG. 2. Gross specimen of cyst (author's case) on cut section. Note the thin fibrous wall and the contents which are light brown, partly gray, opaque, fatty, granular, pasty, semisolid material.

its mesentery resected, followed by an end-to-end anastomosis. The patient made an uneventful recovery and left the hospital in fifteen days. The pathologist's report revealed the specimen to consist of a resected segment of small intestine measuring 24 cm. in length; attached to it was a triangular-shaped mesentery. Protruding from one surface of the attached portion of mesentery and displacing one of the flat layers which was smooth and intact over it, there was a large, spherical cystic mass measuring 8.5 cm. in diameter. There were no gross abnormalities in the resected segment of small intestine. The wall of the cyst was thin and fibrous and it varied between less than 0.5 and 1 mm. in thickness. The cyst contained partly light brown and partly gray, opaque, fatty, granular, pasty, semi-solid material. The lining surface was smooth, partly trabeculated and there were a few scattered, irregular, light brown patches. (Figs. 1 and 2.)

Microscopic examination of the cyst wall showed it to be made up of dense, fibrous, partly hyalinized connective tissue. On the lining aspect there was an irregular layer of macrophages, some of which contained hematogenous pigment. Others had abundant vacuolated cytoplasm suggestive of lipoid content. On the external aspect there was some compressed fatty tissue outside of which moderately thickened serosa was seen. In one of the sections a small, well preserved lymphnode was found attached to the external aspect of the cyst. There was no evidence of malignancy. Diagnosis was benign mesenteric cyst.

SUMMARY AND CONCLUSIONS

1. A case of mesenteric cyst in a female aged fifty-four is reported. The history in this instance was one of recurring attacks of abdominal pain and distention over a period of six months. A round, smooth, tender, movable tumor mass was detected on examination. By means of elimination of other possible and more common conditions a correct preoperative diagnosis of mesenteric cyst was made. Treatment consisted of resection of the involved bowel and cyst employing an end-to-end suture anastomosis. The patient recovered.

2. Differences of opinion in regard to classification of these cysts is due to their obscure etiology. Some believe them to have a multiple origin and therefore have classified them according to their physical properties while others state definitely that they are embryonic in origin and have classified them on this basis. The case herein reported is believed to be one of true mesenteric cyst arising from mesodermal remnants.

3. Mesenteric cysts, especially the chylous type, are fairly rare. These cysts should be more frequently considered in the differential diagnosis of abdominal tumors.

4. The treatment is surgical and consists of removal by that technic which seems best adapted to the particular case after it has been studied through the open

abdomen. Procedure in the order of desirability is as follows: (1) enucleation; (2) extirpation with removal of the involved mesentery and adjacent bowel followed by anastomosis; (3) marsupialization; (4) aspiration.

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Case Reports

MEDIASTINAL LIPOMA WITH INCLUSION OF REMNANTS OF THYMUS GLAND*

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IN a review of the literature the authors have been able to find only forty-seven cases of mediastinal lipoma reported. Heuer[1] collected thirty cases from the literature and added one of his own. In a collective review on mediastinal tumors Heuer and Andrus[2] brought the total number of cases up to forty-two. Recently Watson and Urban[3] and Blades[4] have reported cases making a total of forty-seven. Since this lesion is uncommon and offers difficulty in diagnosis, the authors wish to report a case of mediastinal lipoma in which the remnants of the thymus gland were incorporated within the tumor.

DIAGNOSIS AND TREATMENT

In thoracic lipoma the symptoms may be extremely mild or quite marked and usually bear no direct relationship to the size of the tumor. One may obtain a history of progressive dyspnea, orthopnea or only a feeling of intrathoracic oppression. A non-productive cough may be an early symptom. Pain is usually a late finding. The physical findings are not characteristic and will depend upon the size and location of the lesion. Occasionally a mistaken diagnosis of fluid in the pleural cavity is made and aspiration is attempted. In such a case no fluid will be obtained; however, a sensation of entering a buttery or boggy substance is experienced.

Two clinical types of thoracic lipomas are recognized, namely, those that are entirely intrathoracic and those that are intrathoracic with an extrathoracic extension. In the latter the correct diagnosis is more likely to be made. It is in the intrathoracic type that some difficulty is met with since the symptoms produced by such a lesion are similar to those encountered with other types of mediastinal tumors. The most common location is in the cardiophrenic angle.

Roentgen examination of the chest usually shows a well defined mass that may limit itself to the mediastinum. However, the entire pleural cavity may be occupied. The true nature of the mass may be suspected by the homogenous density with the periphery being less opaque.

With the recent advances in pre- and postoperative care, endotracheal positive pressure anesthesia and surgical technic, these lesions should be treated surgically since there is danger of the tumor causing compression of vital structures or undergoing malignant changes. X-ray therapy has no place in the treatment of this condition. A total removal in one stage is preferable. However, in certain circumstances a two-stage procedure may be necessary as in the involvement of both sides of the thoracic cavity.

CASE REPORT

CASE I. R. N., No. B 95689, a thirty-five year old, white, married female was seen in the out-patient department on December 9,

FIG. 1. Preoperative roentgenogram of chest showing mediastinal density extending superiorly from the cardiophrenic angle.

1946, complaining of exertional dyspnea and occasional wheezing. Approximately ten years previously, following a routine fluoroscopic examination of the chest, a mass was noted in the mediastinum. A diagnosis of "enlarged right side of the heart" was made. She was asymptomatic except for mild exertional dyspnea. About five years ago she developed marked orthopnea and required five pillows for relief. She noted that she could sleep lying flat on her left side without dyspnea or orthopnea. Four years ago she had malaise, easy fatiguability, nausea and vomiting. X-rays of the chest again showed the tumor mass previously noted. Hospitalization and operation were advised but were refused at this time. She improved with symptomatic treatment except for exertional dyspnea. Four months prior to admission she noted expiratory wheezing and she developed a non-productive cough; dyspnea became more marked. She gave no history of productive cough, hemoptysis or chest pain. X-rays made on her clinic visit revealed a mediastinal tumor mass on the right. She was hospitalized on January 27, 1947.

Physical examination revealed a normal temperature, pulse and respiration. Her blood pressure was 120/78. The patient appeared to be well developed, well nourished and in no

obvious respiratory distress. There were no cervical masses or distention of the neck veins. Examination of the chest showed equal and good expansion bilaterally. Tactile fremitus was slightly increased over the lower middorsal region of the right chest; percussion note was resonant. The inferior mediastinum anteriorly on the right was about 5 cm. wider than normal. Lateral to this area breath sounds were bronchovesicular with many squeaky rales.

Laboratory findings were hemoglobin, 15.5 Gm.; white blood cells, 15,880 with an essentially normal differential blood count. Serology tests for syphilis were negative; urinalysis showed no abnormalities. Blood chemistry studies were all within normal limits. Roentgenograms and fluoroscopy of the chest showed a large, dense, homogeneous shadow lying anterior and lateral to the heart on the right side. (Figs. 1 and 2.) The superior mediastinal shadow was not enlarged. The periphery of the mass was less dense than the central portion and it did not pulsate. The electrocardiogram was normal. Vital capacity was 2,800 cc. in 15 seconds. The resting minute ventilation was 12.6 L. with the maximum minute ventilation being 33 L. at 33 per cent of the vital capacity.

Bronchoscopy revealed only moderate thick-
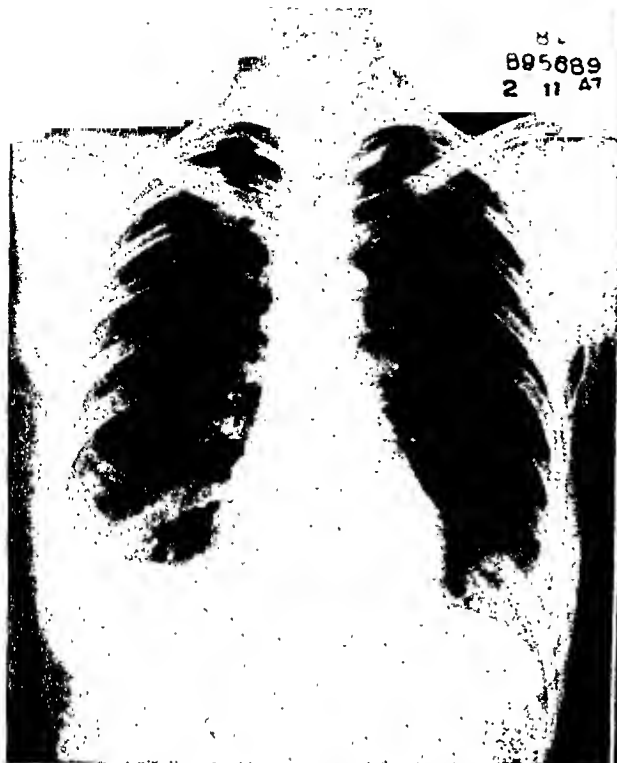
FIG. 2. Postoperative roentgenogram of chest.

FIG. 3. Illustration showing lesion encountered at operation.

FIG. 4. Photograph of specimen. The lipoma weighed 625 Gm. Remnants of fibrotic thymus tissue were found incorporated within its substances.

ening of the carina between the right middle and lower lobes. A 'diagnosis of mediastinal lipoma and chronic obstructive emphysema was made. On February 3, 1947, an operation was carried out by one of us (G. B. H.) under endotracheal ethylene-oxygen-ether anesthesia. A right posterolateral thoracotomy incision was made in the sixth interspace. A large mediastinal lipoma was found which shelled

out easily. The tumor extended from the cardiophrenic angle over the surface of the pericardium and base of the heart (Fig. 3) to the anterosuperior mediastinum where a small pedicle was found about 4 cm. above the arch of the aorta. It descended inferiorly on the left side of the heart for a short distance. The lipoma weighed 625 Gm. (Fig. 4) and measured approximately 24 by 19 by 8 cm. Microscopic examination showed a typical lipoma and in the

more central portion of the tumor remnants of fibrotic thymus tissue were found. The patient had an uneventful postoperative course. Ventilation studies showed no significant changes. The patient improved and was discharged from the hospital on the tenth postoperative day.

SUMMARY

We have been able to find only forty-seven cases of mediastinal lipoma in the literature. Successful operative removal of these lesions has been performed only in recent years. The diagnosis usually can be suspected from the roentgenogram. Early removal is recommended since these tumors may attain an enormous size and encroach upon vital structures or undergo a malignant change.

An additional case of mediastinal lipoma with remnants of thymus tissue is reported in which the diagnosis was made pre-operatively and a successful, complete extirpation was performed.

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AMEBIASIS*

CONSIDERATION OF ITS SURGICAL ASPECTS AND TREATMENT

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PREVIOUS to World War II the incidence of human infection with Endameba histolytica in the United States was well over 10 per cent. Craig[1] stated that 30 to 40 per cent of the people in some communities harbored these parasites. Craig and Faust[2] estimated the total population involved to be over 13,000,000. Ochsner and DeBakey[3] computed the potential number of hepatic complications alone from E. histolytica to be approximately 300,000 to 600,000 which they considered represented only one-half of the existent surgically significant complications.

To these figures must now be added those cases which have developed during and after World War II. Since thousands of our men and women served in tropical and subtropical areas in which they were subjected to the hygienic hazards of war zone living, it is reasonable to assume many of them became infected with E. histolytica. Therefore, it seems timely to call attention to the frequency with which amebiasis may be encountered and to the importance of recognizing the bizarre symptoms which it may produce.

A generally accepted classification of amebic lesions which are of surgical significance is as follows:

I. Intestinal Lesions—(1) appendicitis; (2) perforation with resulting peritonitis; (3) massive hemorrhage; (4) "ameboma" (Amebic granuloma); (5) cicatricial stenosis; (6) pseudopolyposis.

II. Extra-intestinal Lesions—(1) hepatic abscess; (2) pleuropulmonary affections; (3) cerebral abscess; (4) cutaneous ulceration and abscess; (5) splenic abscess; (6) genitourinary affections.

Pathologic findings in amebiasis are characteristic and result from two types of action on the part of the invading protozoa: By mechanical action the pseudopods invade the tissues and by toxic action the host is effected both locally and generally. Three types of lesions are commonly seen: (1) shallow ulcerations, (2) diffuse granulations with ulcerations and (3) sharply circumscribed nodular projections between which are depressed yellow openings leading to gelatinous cavities. According to Strong,[4] human infection occurs only as a result of the ingestion of cysts which undergo development in the intestine and give rise to small trophozoites which attach themselves to the epithelium of the large bowel. Rapid penetration of the intestinal mucosa with entrance of the organisms into the submucosa lead to formation of small gelatinous necrotic areas or abscesses. Rupture of these abscesses causes ulcers and may be followed by secondary bacterial invasion. The most characteristic gross change is hyperemia and thickening of the wall of the large bowel. While all coats may become involved, the process is most extensive in the submucosa. Stasis of the fecal flow favors development of amebic lesions; consequently, the cecum, appendix, rectum and sigmoid colon are more frequently involved than the transverse colon. For instance, Faust[5] found at autopsy 33.3 per cent of the lesions to be in the cecum, 32.1 per cent in the appendix, 15.6 per cent in the rectum, and 12.8 per cent in the sigmoid while only 4.4 per cent occurred in the transverse colon.

Amebic lesions of the appendix, both the acute and chronic forms, may be

extremely difficult to diagnose because the clinical symptoms are frequently not distinguishable from those caused by bacterial infections. Pain and tenderness over McBurney's point are the most common symptoms and in the absence of diarrhea, which occurs in the vast majority of cases, diagnosis may easily be missed. These points are illustrated in the following case reports:

CASE REPORTS

CASE I. Mr. S. W., aged twenty-five, an infantryman who served in New Guinea, entered the hospital with a history of an attack of severe pain over the entire abdomen, nausea, vomiting and tenderness in the right lower quadrant. This had begun four weeks previously and lasted three days. Diagnosis of appendicitis had been made but operation was deferred because the process was considered to be subsiding. Twelve hours before admission he had had a similar attack and again a diagnosis of appendicitis was made by another doctor. During the interval between attacks his bowels had moved once a day and he could recall no episodes of diarrhea. On examination a definitely localized area of tenderness was found in the right lower quadrant. There was slight muscle spasticity but no mass could be palpated. His temperature was 98.8°F. and the leukocyte count was 14,000; sixty-four per cent of the white cells were polymorphonuclear leukocytes. Treatment was conservative. During the following week on six consecutive days soft-formed stools revealed no amebae, cysts, blood or pus. Cultures proved positive for E. histolytica. A course of antiamebic treatment was given and the patient made a rapid and uneventful recovery.

CASE II. Miss J. B., aged twenty-two, a world wide traveler, entered the hospital with complaints of abdominal cramps and tenderness in the right lower quadrant. The cramps and tenderness had persisted since an attack of diarrhea a week previously and had lasted three or four days. Her temperature varied from normal to 102°F. during that time; admission leukocyte count was 20,000. The urine disclosed negative results and two stool examinations made previous to entrance failed to reveal the presence of amebae. On examination marked tenderness with some rigidity

was found in the right lower quadrant of the abdomen. No mass could be palpated; pelvic examination was negative. A diagnosis of appendicitis with spreading peritonitis was made and a laparotomy was performed. The peritoneum was found to be injected and edematous and a distended, dark red cecum with a thickened leather-like wall bulged through the incision. Considerable difficulty was encountered in removal of a retrocecal appendix. Emetine therapy was started immediately on the basis of pathologic findings and cultures taken from the removed appendix showed amebae to be present. Five days later the patient died of generalized peritonitis.

Appendectomy in the presence of an amebic infection of the bowel carries a high mortality and the outcome just mentioned is not an unusual one. Edema and thickening of the bowel wall make suturing and invagination of the appendiceal stump a dangerous procedure. Perforation of the bowel is likely to occur at the time of surgery or at a later date, resulting in gross contamination of the peritoneal cavity. Recognition of amebiasis as the underlying essential manifestation of appendicitis will save many lives. Treatment is not operative. With the proper use of amebacides which are non-irritating to the bowel, spontaneous rupture rarely occurs.

Fortunately, perforation of the bowel does not often occur. The symptoms it produces are those of local or generalized peritonitis. Usually a severe form of amebiasis precedes perforation. Treatment with amebacides is conservative and the patient is carefully observed. Should an abscess develop drainage must be established to prevent rupture of the abscess into the abdominal cavity. Prognosis in these patients is not good.

Another complication seldom seen which may arise in fulminating amebiasis is massive hemorrhage from the bowel. Here again the treatment is conservative. Amebacides are used and blood transfusions are given as indicated by blood loss. Prognosis as would be expected is bad.

Amebic granuloma or ameboma, as defined by Ochsner and DeBakey, is a tumefaction of the bowel wall which follows repeated invasions of amebae and is the result of progressive destruction and replacement of bowel tissue by fibrous tissue. Ameboma occurs most frequently in the region of the cecum or sigmoid as a firm, nodular, granulomatous, inflammatory mass and may present difficult problems in both diagnosis and treatment as illustrated by the following case report:

CASE III. Mr. J. N. aged twenty-five, was admitted to the hospital with a history of amebic dysentery occurring two years previously. This had been successfully treated, and he had been without symptoms until one month prior to the present time when he developed alternating diarrhea and constipation. Two weeks before entrance into the hospital generalized abdominal pain, cramping in character, caused him to consult his doctor. A course of vioform was taken although no amebae were found in the stools. Twenty-four hours previous to admission the abdominal cramps became increasingly severe, he became nauseated, vomited and noticed his abdomen rapidly "ballooning up." Examination revealed a uniformly distended abdomen with considerable borborygmus in the upper portion. No peristaltic waves could be seen. X-ray showed a stepladder arrangement of loops of distended small bowel. A napkin-ring deformity at the junction of the sigmoid and rectosigmoid suggested malignancy. No amebae were found in the stools, smears or cultures. Laparotomy revealed a markedly distended small bowel and colon as far distal as the sigmoid where an annular constriction approximately 2.5 cm. long was producing an acute obstruction. The appendix was the size of an index finger, the colon friable and injected. Obviously cecostomy was a difficult procedure. Postoperative recovery was uneventful except for several areas of ulceration which developed on the mucosa of the stoma. These were covered by grey membranes which bled readily and sloughed away at several points. Smears taken from these areas showed many amebae to be present. A series of emetine injections with local application of chiniofon resulted in rapid healing. Ten months later the patient's doctor reported him to be a well man.

Although the aforementioned patient probably has no carcinoma, there are in our records two case histories of patients with carcinoma of the large bowel and concurrent amebiasis. One of these patients was treated for a considerable time with amebacides before he was found to have an inoperable carcinoma. It is a well known fact that large amebic granulomas in patients of cancer age may be impossible to differentiate from malignancies. Recently Druckmann and Schorr[6] have called attention to eight salient points in the roentgenologic differentiation of amebic granuloma from malignant new growths of the large intestine. In amebic infections roentgenograms usually show the presence of a single extensive lesion with smaller defects adjacent. However, when no smaller adjacent lesions are present, differences in x-ray findings between amebiasis and carcinoma may be indistinguishable. Golden and Ducharme[7] state, "Carcinoma of the cecum usually produces an irregular asymmetrical filling defect associated with a palpable mass, whereas the deformity of amebiasis is smooth, regular and not associated with a palpable mass. A mass produced by a large amebic granuloma of the cecum cannot be differentiated from carcinoma." Numerous reports appear in the literature of instances in which colonic resections have been made following which the removed lesion proved to be of amebic rather than of carcinomatous origin.

Cicatricial stenosis is found most often in the region of the cecum or sigmoid although occasionally it occurs in the rectum. It is the result of repeated infections which cause a gradual replacement of normal bowel tissue by scar tissue. This takes place either in local areas or more rarely along the entire bowel. Surgery may become necessary for relief of partial or total obstruction, however, amebacides should always be given first. The following case history is typical of this form of complication:

CASE IV. Miss G. W. aged twenty-three, entered the hospital because of constipation

and pain on defecation. Six years previously she had developed diarrhea which lasted two years, and while her condition improved there had been many recurrences. Nine weeks before admission amebae were found in her stools and she was treated with emetine. Examination revealed an undernourished patient with moderate tenderness over the entire abdomen. Nine cm. from the anus a rectal stricture would admit only the tip of the examining finger. Stools contained blood, mucus and many amebae. Emetine was given and ten days later an ileostomy was performed from which the patient made an uneventful recovery.

Pseudopolyposis is rare and follows repeated amebic infections occurring over long periods of time. It may be confined to a localized area or extend along the entire course of the colon. Should hypertrophy of the mucosa become extensive enough to warrant surgical excision, a thorough course of medical treatment must be given prior to surgery.

Extra-intestinal Lesions. Of the lesions found outside the intestinal tract hepatic abscesses are the most common and of greatest importance. The frequency with which these occur has been estimated to be about 0.5 per cent in patients with clinical manifestations of the disease and 36 per cent in fatal cases. Over 80 per cent are found in males and the majority are in those between twenty and fifty years of age. Occurrence in patients from six to seventy years of age has been reported but very few in those under fifteen or over fifty. Trauma, exposure, starvation and alcoholism may act as predisposing factors by lowering the resistance of the liver.

Production of thrombi and infarcts, along with the digestive action of the amebae on the liver cells, play an important rôle in the development of liver abscesses. In the early stages only a small area of liquefaction necrosis may be present. The older, well developed abscess contains a thick, reddish-brown fluid or "chocolate sauce," which is composed of necrotic liver tissue and cells, leukocytes

and blood. Seldom does it contain amebae and usually it is sterile. If secondary pyogenic infection has taken place, the fluid is somewhat yellow in color. Most amebic abscesses are single in contrast to the multiplicity of pyogenic abscesses although in severe fatal cases multiple abscesses are often found. The right lobe of the liver is more frequently involved than the left.

Pain, of a dull aching character beginning in the right upper quadrant or epigastrium and referred to the right shoulder, is a characteristic symptom. Later the pain may become piercing or stabbing especially if rupture of the abscess takes place. Usually the temperature is high in the early stages and follows a remittent course. In the chronic stage the temperature may be normal. Enlargement of the liver may be great enough to be visable. Tenderness accompanies the enlargement and usually there is decreased respiratory movement, muscle rigidity and dullness on the affected side. Anorexia, fatigue, weakness and loss of weight are not uncommonly present. The frequent absence of diarrhea may be somewhat misleading; and while these abscesses usually develop within two or three months after the initial infection of the colon, there are times when they may not appear for as much as forty years later. Examination of the blood shows a leukocytosis without a percentage increase in polymorphonuclears as seen in pyogenic infections. The highest count we have seen was 20,000, with an average below 15,000. While there is a definite increase in eosinophils, it is usually not marked. A slight secondary anemia is often present. X-ray findings are positive in over 80 per cent of cases and are characterized by an irregular liver surface outline, with a local bulging of the diaphragm at the site of the abscess. If rupture has occurred into the subphrenic space, the cardiophrenic angle is obliterated in the anteroposterior view and the anterior costophrenic angle in the lateral view. Most important to diagnosis is the finding of

E. histolytica in the stools or fluid from the abscess. Inability to demonstrate the parasites does not, however, preclude a diagnosis for in only 30 per cent of our patients have positive cultures been obtained. The complement fixation test of Craig is a valuable test and should not be overlooked.

Diagnosis usually is not difficult if the history, physical, x-ray and laboratory findings are properly evaluated while the possibility of a hepatic abscess is kept constantly in mind. Additional aids which have been employed in making or confirming a diagnosis are the diagnostic puncture and the peritoneoscope. Dangers accompanying their use are penetration of the pleural cavity, hemorrhage and spread of infection. Illustrative of some of the important features of hepatic abscess are the following case histories:

CASE V. Mr. T. S. aged forty-seven, entered the hospital because of persistent tenderness in the right upper quadrant, chills and fever. The tenderness had been present for six weeks as well as episodes of chills and fever of three week's duration. Onset had followed a heavy formal dinner which included cocktails and liqueurs. Sharp pains in both right and left upper quadrants accompanied each attack of chills and fever. No nausea or vomiting had occurred and all stools had appeared normal to him. He presented cholecystograms which showed no filling of the gallbladder. His doctor had diagnosed cholecystitis and recommended that surgery be performed. Upon examination the physical findings were essentially negative except for those of the abdomen. A smooth, firm, tender liver was palpable 3 fingerbreadths below the right costal margin. The left lobe was also enlarged but to a lesser degree. Proctoscopic examination revealed a normal rectal mucosa. Cultures taken proved positive for E. histolytica and small amounts of blood, mucus and pus were found in the stools.

Emetine therapy promptly eliminated his symptoms and enlargement of the liver rapidly subsided. The patient was at work again within a few weeks time.

Not so fortunate was the patient whose case history follows:

CASE VI. Mr. W. G. aged forty, was admitted to the hospital because of an acute upper respiratory infection of ten days' duration and abdominal pain in the right upper quadrant which began a few days after the onset of the cold. The abdominal pain was aggravated by deep breathing. Bowel movements had been regular, with no diarrhea at any time and apparently there was no relationship between bowel activity and his pain. Two years previously while serving in the European theater he had developed an abscess which was drained at the level of the twelfth rib on the right as evidenced by a healed operation scar. He was of the opinion that the liver had been involved. Otherwise his past history was negative and he had been in good health until the onset of his present symptoms. Upon examination the important findings were a few moist rÃ¢les at the base of the right lung, slight epigastric tenderness and an enlarged, smooth, firm liver palpable 2 fingerbreadths below the right costal margin after deep inspiration. Proctoscopic examination revealed no abnormalities of the rectal mucosa. The temperature was 100°F. and the leukocyte count 16,000. Fluoroscopy showed a slightly limited motion of the right diaphragm but no irregularity of the surface could be demonstrated. There was no fluid in the pleural cavity. After repeated examinations E. histolytica cysts were identified in the stools. A course of emetine therapy was given and response was immediate. His abdominal pain and temperature subsided, appetite and weight increased and stools were negative for amebae. Six weeks later he developed another cold accompanied again by abdominal pain, chills and fever. A pleural friction rub could be heard on the right and a moderate degree of tenderness was present over the liver. While x-rays of the chest were being made, he experienced a sudden, severe, sharp pain which involved the entire right abdomen. Following this, the abdomen became rigid and bowel sounds diminished. At operation a large liver abscess which had ruptured into the peritoneal cavity was drained. Convalescence was satisfactory.

In the early stages of hepatic abscess when the process is simply an acute inflammation treatment is primarily medical and often a course of emetine is adequate. On the other hand, if a true abscess develops, surgical drainage then becomes

necessary. It should be emphasized, however, that if surgery is necessary the patient should be given preoperative emetine therapy unless rupture appears imminent. Lindskog and Walters[8] state that preoperative emetine reduces the mortality rates from 60 to 3 per cent. Long ago, surgeons experienced in the care of amebiasis adopted the closed method of drainage in preference to the open method for evacuation of these abscesses. As a result an amazing reduction in mortality occurred and since that time closed drainage has been the method of choice except in those cases in which secondary infection is present. Great care should be exercised in introducing the aspirating needle to avoid both the pleural and peritoneal cavities. Because of the viscosity of the contents of the abscess, a trocar is necessary at times instead of an aspirating needle. Although most of these abscesses are sterile, facilities for performing open drainage should always be available. Penicillin and the sulfonamides may be used to advantage if cultures reveal susceptible bacteria to be present.

Prognosis is greatly influenced by the presence or absence of secondary infection, various complications which have arisen, types of treatment which have been used and other factors. Ochsner and DeBakey found in 4,760 collected cases a mortality rate of 44.2 per cent following open operation in contrast to 6.7 per cent in patients treated by aspiration and amebacides. Complications increased the rate from 8.4 per cent to 39.4 per cent. Most frequent complications are perforation into the subphrenic space, pleuropulmonary involvement, embolic transmission to the brain and generalized peritonitis resulting from rupture into the abdominal cavity.

Pleuropulmonary amebiasis, which is next in frequency to hepatic abscess, may develop either by way of the blood stream or by direct extension from the liver. While the symptoms and findings vary with the type and extent of involvement, severe, persistent pain in the right lower chest radiating to the shoulders is usually present. This may be accompanied by a non-productive cough. The roentgenograms usually show a characteristic bulging or triangular shadow on the affected side. Should perforation develop a large amount of so-called "chocolate sauce" pus is expectorated. Following a new bronchohepatic fistula, amebae may be recovered from the sputum. We have seen only one case of bronchohepatic fistula, but in those reported the mortality has been high.

Cerebral amebiasis is rare and occurs usually in the presence of an overwhelming infection. Hepatic and pleuropulmonary complications frequently precede involvement of the brain and transmission is thought to be by way of the blood stream. Symptoms are those of a pyogenic abscess. The prognosis is bad.

Cutaneous amebiasis is very infrequent and has been classified into the following groups by Engman and Meleney:[9] (1) those following drainage of an amebic hepatic abscess; (2) those following drainage or rupture of an amebic intestinal lesion such as appendicocecal abscess, pericolic abscess, fecal fistula, colostomy or other operations upon the large bowel; (3) perianal extension of an amebic infection in the distal portion of the rectum; (4) primary cutaneous involvement in the absence of direct visceral connections. Treatment consists of emetine and radical excision plus restoration of depleted proteins and vitamins.

Splenic abscess and genito-urinary amebiasis are both rare forms of the disease. Usually the genito-urinary tract is involved secondary to an abscess in the liver. Lesions have been reported in the ovaries, tubes, cervix, vagina, testes, prostate, epididymis and penis. In all these conditions medical treatment is of primary importance.

SUMMARY

Amebiasis, a disease of wide, prewar distribution, has now assumed even greater importance. Over a million people in this

country have surgical complications. Amebiasis is of great importance to the surgeon because of its close similarity to other diseases, such as appendicitis, cholecystitis, carcinoma of the colon, perforated peptic ulcer and pancreatitis. Expert judgement and care are required for its successful management. Treatment is primarily medical and all surgical procedures should be preceded and accompanied by medical therapy. Unnecessary surgery in misdiagnosed patients invariably results in a high mortality.

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TODAY we have become cognizant of the importance and diagnostic value of finding tumor cells in various bodily secretions. No wonder, therefore, that chest specialists have begun to remind us of the importance of looking for cancer cells in the sputum of patients with suspected bronchogenic carcinoma. One recent authority found that by such cytologic examination the correct diagnosis could be made in approximately three-fourths of all such cases. One must look for abnormally large cells, hyperchromia, bizarre, abnormally large nuclei and especially for mitotic figures. All these diagnostic features help to point toward the correct diagnosis. This is true exclusively in the hands of experienced observers. Beginners are bound to make erroneous diagnoses. (*Richard A. Leonardo, M.D.*)

SURGERY OF ILEAL TUMORS*

REPORT OF A CASE OF INTUSSUSCEPTION LED BY LIPOMA OF THE ILEUM

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TUMORS of the small intestine are relatively uncommon and, of these, most are located in the ileal region. Raiford believes this to be due to the comparative freedom from stasis which exists in the small intestine.[1] He states that the terminal ileum is the only segment of the small intestine in which the fecal contents are retarded and accumulate before passing into the cecum. Stasis is believed to be one of the contributary causes of irritation which, in turn, is supposed to predispose to tumor formation, particularly of the malignant type.

Of Raiford's series of eighty-eight tumors of the small intestine, derived from examination of 11,500 autopsies and 45,000 surgical specimens, lymphoblastomas were the most common, occurring in twenty-one cases, twenty of which were in the ileum. Adenomas were next in frequency, consisting of fifteen cases, eleven of which were located in the ileum. Lipomas were the third type in frequency. In reviewing the literature Shottenfeld[2] found that more than one-half of all the lipomas of the gastrointestinal tract were located in the small intestine and almost one-third were located in the ileum. About eighty cases of ileal lipomas have been reported to date. Of the remainder of the benign types, fibromas, myomas, argentaffin or carcinoid tumors, accessory pancreatic rests and angiomas also have been reported. Eighteen per cent of Raiford's series[1] consisted of malignant tumors, in which carcinoma was located less frequently in the ileum, whereas sarcoma predominated. The lymphoblastomas usually are regarded as a borderline group.

Tumors of the small intestine may grow internally or externally. The great majority of the tumors, especially the benign, assume the internal form. Most of these are polypoid, usually adenomas and lipomas. Although any histologic type may assume the form of a polyp, the benign ones are usually small and often multiple. Sessile types are oval or round and are classified as intramural when they lie within the wall of the intestine; or they may be attached by a broad base and loosely covered by intact mucous membrane. Malignant growths predominate among the external type. They are larger, frequently single and may involve, by direct extension, the ileal lymph nodes and mesentery. They are usually infiltrative, causing a jagged, irregular thickening of the bowel wall, spreading out from the original site and destroying the normal structure of the wall. The lymphoblastomas may assume a constricting form, described by Riaford[1] as a variant of the preceding, in which there is a tendency to necrosis and excavation so that the tumor remains a hollow, irregular sphere through which the lumen passes constricted at its points of entrance and exit.

In proportion to their size polypoid, or pedunculated, tumors, offer the most complications. Lichenstein and Dutra[3] described four of the common complications: necrosis of the tumor mass, bleeding from an eroded surface, partial or complete obstruction of the lumen and intussusception. Intussusception complicates about 30 per cent of all tumors of the small intestine,[4] and lesions producing this complication are benign more often than malignant. Malignancy often causes

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a rigid infiltration of the bowel wall which tends to resist invagination. Intussusception may be caused also by intramural lesions, such as leiomyoma,[5,6] lymphosarcoma of the terminal ileum,[7] combined mural and internal lesions as angiofibroma[3] and by mural embryonic rests composed of duct-forming epithelium and smooth muscle, occurring in the wall of the ileum of an infant.[8] The intussusceptions in these cases probably were incited by peristaltic attempts of the bowel to pass the diseased segment of the wall into the subjacent segment. Intussusceptions of the ileal area may be ileo-ileal, ileocolic or a combination of both and have been described in association with volvulus of the ileum.[9] Allen, Hale and Sniffen[10] discussed an unusual case of benign tumor causing intestinal obstruction without intussusception in which a grossly lobulated, encapsulated leiomyoma of the ileum had eroded in its center to form a pit or diverticulum.

DIAGNOSIS

A great majority of benign tumors are clinically and surgically asymptomatic and are discovered only incidentally at autopsy or exploratory laparotomy. The size, location, peristaltic activity, amount of lumenal obstruction, ulceration and degree of intussusception determine the symptoms and their time of onset. Melena and occasional fever may result from necrosis or from erosion. Complete obstruction may follow intussusception of the tumor-bearing segment of the bowel or may be due to encroachment of a large polyp on the lumen or the impaction of intestinal contents against it. No one syndrome is pathognomonic of any one histologic type. The complete intestinal obstruction may be preceded by months or years of vague abdominal complaints. The obstructive symptoms are of gradually increasing severity with intervals free from pain and other symptoms, such as nausea and vomiting. Intermittent colicky pains, usually in the right lower abdominal quadrant, repeatedly start in the same area. These attacks may end as suddenly as they begin and the patient feels well until the next attack. Constipation occurs frequently and obstipation may be present during the episodes Malaise, weight loss and alternating constipation and diarrhea may be present. This sequence of mild intestinal obstruction followed by a symptom-free period recurring at variable intervals probably results from spasm of the bowel in the vicinity of the tumor or from partial invagination. The symptom-free interval follows relaxation of the spasm or spontaneous reduction of the intussusception.

Physical signs are few, if any. Often an area of localized abdominal tenderness is noted and, in patients with large tumors or intussusceptions, a mass may be felt.

Eventually, complete intussusception may take place with concomitant symptoms and signs of acute intestinal obstruction. There is a sudden onset of severe abdominal pain, usually in the right lower abdominal quadrant, followed by nausea and vomiting. Abdominal distention occurs and bloody stools may be passed, particularly in infants. A tender, sausage-shaped mass may be felt through the abdominal wall. Marked tenderness or muscle spasm may be absent in adults because the peritoneum is protected from the strangulated segment of bowel by the sheath of the intussusceptum.[13] The commonest cause of intussusception among adults is tumor of the bowel.

Hemangiomas of the ileum,[14] which are exceedingly rare, may manifest themselves clinically by melena. Because of the rarity of this origin of melena, a thorough study of the history, physical manifestations and laboratory examinations should be undertaken in an effort to rule out other causes.

From the standpoint of roentgenologic diagnosis the ileum is the most difficult portion of the small intestine to visualize because it is hard to maintain a distending concentration of the contrast suspension

in this region and because this segment tends to seek a low level in the pelvis. Elevation from this position is not always possible.[11] Fluoroscopic methods often are more satisfactory than roentgenograms. Once the evidence of tumor is established there are no reliable x-ray evidences of benignancy. Tumors are manifested by deformity of outline of the ileum, short and sharply demarcated filling defects, by the obliteration of the mucosal pattern throughout the extent of the defect and also by x-ray signs of obstruction. In acute intussusception an x-ray may reveal a cupping defect where the intussusceptum projects into the bowel. In this condition postevacuative and air contrast films occasionally are more helpful.

Patients must be selected carefully because the time-consuming examination increases the amount of radiation received by the patient and the examiner.[12] The use of x-ray may be disappointing except when carried out during or just after a period of obstruction; in such instances, a flat plate may reveal distended loops of small intestine with the characteristic stepladder arrangement and fluid levels present in the distended loops. Barium sulfate by mouth is contraindicated in acute obstruction. When chronic obstruction is present or repeated episodes of complete obstruction occur, it should be used with caution as it can precipitate an acute obstruction. As a rule, barium enema is considered a safer method.

DIFFERENTIAL DIAGNOSIS

The symptoms of right lower abdominal quadrant colicky pains, nausea and vomiting, which may indicate tumors of the ileum, may simulate symptoms of appendicitis, renal colic or tumor, mesenteric adenitis and other benign or malignant tumors of the ascending colon and cecum. A careful history, physical and x-ray examination may help in differentiating these conditions. When obstruction occurs, bowel strangulation from other causes, namely, volvulus or diverticulitis, should

be ruled out. Pain produced by intussusception is intermittent in character and differs sufficiently in intensity from the usual colic of obstruction so that the diagnosis may be suspected clinically. The x-ray appearance of ileocolic intussusception made after a barium enema may help in differentiating.

TREATMENT

The treatment of recognizable tumors of the ileum is surgical. Since neither malignancy nor benignancy can be diagnosed with certainty from the history, physical and x-ray findings, surgical excision, including resection of an adequate margin of healthy bowel on either side of the lesion, is the method of choice. In those cases in which the tumor appears malignant at laparotomy the corresponding ileocecal glands and part of the local mesentery should be removed along with the tumor-bearing area. In radio-sensitive lesions, such as lymphosarcomas, postoperative irradiation should be used.

In like manner, the treatment of intussusception is surgical excision. Hydrostatic methods of reducing the intussusception without laparotomy are contraindicated because of the danger of injuring the bowel and because hydrostatic methods are not able to correct the cause of the intussusception.[13] The Miller-Abbot tube may be used as a measure for decompression of the intestinal obstruction, both pre- and postoperatively. The method of choice is the resection of the segment of bowel involved after the intussusception has been reduced with an ileo-ileostomy or ileotransversostomy, depending upon the location of the tumor in relation to the cecum. It is much safer to apply manual traction to reduce the intussusception as much as possible before resection than to make an incision through the neck of the intussuscepted portion in an effort to provide more room for reduction.[13] The latter procedure may result in making an opening into the obstructed bowel or exposing the gangrenous loop with the

Fixed specimen of the resected terminal ileum, cecum and ascending colon. The cecum has been opened, the invaginated loop of ileum uncoiled and pulled upward and the intussusception exposed. The ileal lipoma, cut across, is seen protruding from the distal end (left lower corner).

subsequent danger of contamination and peritonitis. Before resection and anastomosis, a search for other tumor-bearing areas of the intestines should be made and the necessary procedures should be carried out. Care should be used in suturing the edematous bowel in the intussuscepted segment. In some cases of marked edema and inflammation, simple exteriorization followed by secondary operation may be the procedure of choice.

PROGNOSIS

The prognosis varies with the condition of the patient, the type of lesion and the type of operation. In benign or malignant tumors the prognosis is comparable to that of similar lesions elsewhere in the pgastrointestinal tract. In cases with associated intussusception the prognosis depends upon the duration and may be grave because of necrosis, gangrene, hemorrhage, obstruction and peritonitis which may develop.

CASE REPORT

A white woman, fifty-three years of age, weighing 125 pounds, was admitted to The Hospital for Joint Diseases on March 23, 1946. The patient had malaria in 1920 and had symptoms of Graves's Disease from 1921–1929. A thyroid cyst was excised in 1923, a partial thyroidectomy was done in 1925 and thyroid cysts were removed in 1928 and 1931. The remainder of her past history was not significant.

On admission the patient complained of periumbilical, crampy pain of one week's duration; she had been feeling well prior to that time. The pain was colicky and intermittent and was associated with nausea and retching. She had been constipated, having had bowel movements about once each four days. No melena, pus or mucous was present in her stools. There was no recent change in her bowel habits. Her stools were alternately hard and soft and were described as light yellow. She usually took cathartics. A cathartic taken just prior to admission was vomited but no hematemesis was noted. Distention and eructation were present on admission but there was no flatus. No jaundice was noted. Her pain continued but it was unassociated with nausea after the first day. She had lost five pounds in the three weeks prior to admission and another five pounds one week prior.

Her physical examination revealed nothing significant except that her abdomen was soft and slightly distended and a moderately tender, movable mass was palpable in the right lower quadrant. Rectal examination was negative except for impacted feces.

The laboratory findings were not diagnostic. Urinalysis showed two plus albumen, 1.6 per cent sugar, hyaline casts, many white blood cells and occasional red blood cells. Her blood count and sedimentation rate were normal. Blood sugar was 91 mg., and alkaline phosphatase was 3.5 mg.

After a barium enema, fluoroscopic and radiographic examinations of the large intestine revealed several large globular masses projecting into the lumen of the cecum. A flat plate taken three days later revealed considerable distension of the coils of the small and large intestine.

A Miller-Abbot tube was passed four days after admission in preparation for an explora-

tory laparotomy for a cecal tumor. A transfusion of 500 cc. of whole blood was given. At operation a large, irreducible intussusception was found in the ileocecal region. Through the ascending colon a smooth, round, movable tumor was felt which was considered papillary in nature. The ileum was then transected about 3 inches proximal to the intussusception, a lateral ileotransversostomy was performed and the intervening segment of bowel, containing the lesion, was resected.

The patient's postoperative course was uneventful and she left the hospital fourteen days after the operation.

Pathologic examination of the resected specimen revealed an irreducible, ileocecal intussusception caused by a pedunculated lipoma 3 cm. in diameter and 4 cm. in length arising in the terminal ileum, which had invaginated itself and the ileal segment of its origin into the cecum. The entire intussuscepted mass was about 18 cm. in length and 4 cm. in its greatest diameter; it was edematous and indurated and its dull, reddish-blue, fibrin-coated surface indicated a marked interference with its blood supply.

SUMMARY

1. The terminal ileum is the most common site of tumors of the small intestine.

2. Most of these tumors are benign and their clinical importance depends upon the complications of obstruction, necrosis or intussusception.

3. These tumors are diagnosed by symptoms of vague, colicky, intermittent, pain in the right lower abdominal quadrant. The pain increases in intensity with the onset of the aforementioned complications.

4. Roentgenograms and particularly fluoroscopy are useful aids in diagnosis. The suggestive radiographic signs are filling defects, deformity of bowel outline and evidence of distended bowel.

5. The treatment is surgical and consists of enterostomy and excision, reduction of an intussusception and enterostomy or resection of the tumor-bearing area of the intestine.

6. A case of irreducible, ileocolic intussusception, caused by a lipoma of the ileum and treated by resection of the affected bowel and an ileotransversostomy, is described.

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DIVERTICULA OF THE THIRD PORTION OF THE DUODENUM*

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A PATIENT with diverticulum of the third portion of the duodenum operated upon at the Lankenau Hospital prompted us to review the literature regarding the incidence of this condition. It was interesting to note that little mention had been made concerning the surgical approach and technic of removing diverticula of the third portion of the duodenum, owing undoubtedly to the relative rarity of the condition and to inadequately defined indications for operation. A study of the records at the Lankenau Hospital (5,219 admissions in 1945) revealed only ten patients with the x-ray-confirmed diagnosis of duodenal diverticulum since 1937; nine of these diverticula were in the second portion and in only our case was the diverticulum in the third portion of the duodenum and treated surgically.

CASE REPORT

W. C. B., a twenty-nine year old white male, presented a history of good health until three years before admission at which time he was operated upon at another hospital for generalized abdominal pain. His appendix was removed at that time and he recovered uneventfully except for occasional "dragging" sensations in his right lower quadrant. About six months following his appendectomy the patient began to suffer from indigestion associated with occasional nausea, vomiting and some epigastric pain. The character of this pain was aching, frequently continuous for hours and quite distressing. It was localized to the mid-epigastric region and never extended below the umbilicus. However, the patient stated that his symptoms were not incapacitating until six months later when he suffered sudden hematemesis (of apparently copious quantity). He was seen by his local medical doctor and was treated on a medical regimen but he continued to have occasional minor hematemeses and tarry stools for a period of four months. At this time the hematemesis ceased. No x-rays were taken. The patient continued under the care of his local medical doctor and was able to work as a welder and carpenter but for the remaining two and a half years prior to admission to our hospital he had never been free of his continual indigestion, occasional nausea, vomiting and epigastric distress. He stated that he never ate highly seasoned or spicy foods and there was no intolerance to fats. His aching epigastric pain was most prominent about one-half hour following the ingestion of food. He obtained no relief by drinking milk but alkalies occasionally would lessen his discomfort. The patient denied drinking or smoking and maintained his usual weight of 180 pounds. His bowels moved regularly without laxatives and there was no recent history of melena. His past medical history was non-contributory as was his family history and review of other systems not mentioned here in.

Upon admission physical examination revealed a well developed, white male in his late twenties in no acute distress. His blood pressure was 130/90, temperature 98.3°F., respirations 18 and pulse 80. The only physical finding of any note was that of slight distress on deep epigastric palpation. Peristalsis was audible and there was a healed McBurney scar in the right lower quadrant. The abdomen otherwise was normal. Rectal examination revealed no abnormality.

Laboratory studies were not abnormal in regard to hemoglobin, white blood cell count, urinalysis, serum proteins and icteric index. A gastric analysis was not remarkable.

A one-day gastric x-ray study was performed and a moderate sized diverticulum arising from the superior border of the third portion of the

duodenum was clearly visualized. (Fig. 1.) The diverticulum filled well with barium, but no evidence of any lesion within the sac could be seen. The esophagus, stomach and proximal portions of the duodenum were negative for pathologic conditions. It was the opinion of our staff that the diverticulum could certainly be the cause of the patient's symptoms and because of his comparative youth, good physical condition and not abnormal laboratory reports, surgery was decided upon.
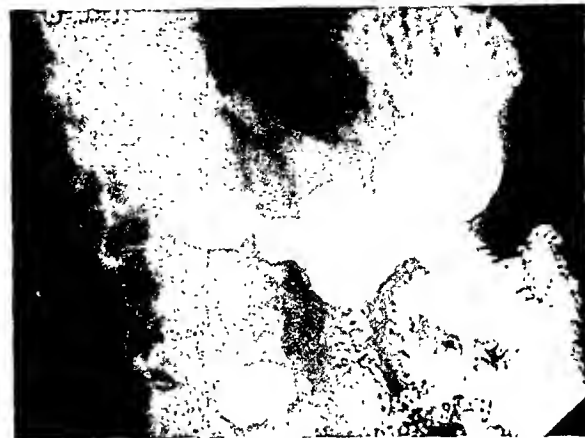
The patient was prepared as for gastric surgery and spinal anesthesia was administered. Through a high, right paramedian, muscle-splitting incision the peritoneum was opened. Exploration of the stomach, the first and second portions of the duodenum and gallbladder revealed no pathologic condition. The large bowel and other viscera were not abnormal. A thick, heavy omentum was found attached to the old appendectomy scar. This was freed and the excess omentum was excised as it interfered with exposure of the operative site. The transverse mesocolon was divided to the right of the middle colic artery, exposing the third portion of the duodenum and the head of the pancreas. The lower border of the head of the pancreas was elevated superiorly and an attempt was made to separate it from the third portion of the duodenum. Considerable bleeding was encountered from small pancreaticoduodenal branches and these were clamped and ligated. The superior mesenteric vessels were then retracted medially and the third portion of the duodenum was more fully demonstrated and dissected free from inferior contiguous structures. This portion of the duodenum was then rolled upward, exposing, on the posterior superior surface, a diverticulum approximately 3 cm. in length and 1.5 cm. at its greatest width. This was attached to the duodenum by a somewhat narrow neck arising from the posterosuperior surface of the third portion of the duodenum near its junction with the fourth portion. Some fine fibrous adhesions binding the diverticulum closely to the duodenum were lysed. The diverticulum was clearly demonstrated and the blood vessels supplying it were divided between clamps and ligated.

The duodenum was then allowed to roll back into its normal position and the diverticulum was brought forward between the

FIG. 1. Case of W. C. B. Barium meal reveals a large, well filled diverticulum of the third portion of the duodenum.

inferior border of the pancreas and the mesenteric border of the duodenum. This was accomplished by carefully rotating the third portion of the duodenum so that the anti-mesenteric border was posterior. The neck of the diverticulum was divided between Kelly clamps and turned in using a Parker-Kerr stitch transverse to the axis of the bowel. A second line of closure was made with interrupted linen sutures. The patency of the duodenum was demonstrated, there being more than a one-finger breadth lumen. All bleeding was observed to be controlled. The defect in the transverse mesocolon as well as the peritoneum were closed with continuous catgut sutures. The incision was then closed in layers without drainage and clips were placed in the skin.

The pathologist confirmed the gross diagnosis of a primary diverticulum (containing all intestinal layers) and no ulceration or other pathologic disorder was found to be present in the specimen.

The patient convalesced excellently until the twelfth postoperative day at which time his temperature suddenly rose to 102.2°F. and he suffered pain in the epigastrium associated with nausea and vomiting. On the thirteenth postoperative day his incision was reopened under general anesthesia and a peri-duodenal abscess was drained through the gastrocolic omentum. His convalescence from this point on was uneventful and he was discharged with no complaints whatsoever on the thirty-fourth day following the excision of the diverticulum. (Fig. 2.)

FIG. 2. Postoperative barium meal reveals absence of the diverticulum.

SURGICAL APPROACH

We agree with Pearse's[1] statement that the excision of diverticula of the third portion of the duodenum presents no particular problem except that of adequate exposure. Indeed, we believe that adequate exposure is the main obstacle of the procedure and there are several pitfalls which may be encountered in achieving this goal.

In view of our experience with this case we are re-emphasizing the following points in procedure: (1) The most direct approach is through the transverse mesocolon, being careful to avoid the middle colic artery. (As Morton[2] says, the relatively inaccessible third portion of the duodenum can be demonstrated by approaching this part of the duodenum through the transverse mesocolon.) (2) Proper mobilization of the duodenum as stressed by Strauss[3] is essential to demonstrate adequately the diverticulum which is usually on the posterosuperior surface of the duodenum. This entails careful retraction of the superior mesenteric vessels toward the ligament of Trietz, permitting safe dissection of the duodenum from the retroperitoneal structures and exposure of its posterior surface by rolling the anti-mesenteric border forward and superiorly. The approach from the medial side of the duodenal loop is difficult and annoying as verified by Morton.[2] There are many small branches from the pancreaticoduodenal vessels which enter the duodenum about the head of the pancreas, and we found these to be troublesome when we at first attempted an anterior approach. (3) Identification of the sac, dissecting it free and amputating it at its neck may then be achieved by direct observation of the posterior duodenal surface. If the neck of the diverticulum should be found quite close to the mesenteric border, the sac may then be delivered anteriorly by rotating the anti-mesenteric border posteriorly, permitting the diverticulum to lie anterior to the pancreas. This maneuver will permit easier amputation and closure of the stump. The stump may then be over-sewed with interrupted sutures and the duodenum allowed to fall back into its normal position. Maclean[4] describes a noteworthy procedure in the event that the diverticulum cannot be adequately demonstrated. He advocates opening the duodenum and searching the mucosa for the mouth of the sac. The index finger or a probe, depending on the breadth of the neck, may then be inserted transduodenally and dissection of the diverticulum carried out, using the finger or probe as a guide. (4) The question of drainage is certainly worthy of mention, and due to the postoperative complication in our case we are naturally prone to advocate a rubber tube drain to the site of operation through the gastrocolic omentum and the wound closed in layers about the drain.

COMMENT

To attest to the relative rarity of the condition, Case[3] found diverticula of the third and fourth portions of the duodenum in only seventeen cases in a series of 6,847 consecutive barium meals. He found both sexes equally susceptible and the average age for clinical symptoms was fifty-six years.

Boyd,[5] however, states that diverticula of the duodenum are much commoner than formerly considered. He describes primary diverticula as arising usually

from the second part of the duodenum, sometimes the first part and rarely from the third part. The diverticulum may be single or multiple, sometimes producing no symptoms; but when large, Boyd concludes that the diverticulum may cause dyspepsia from pressure.

We are thoroughly in accord with L. M. Rankin's[6] statement that there is no clinical syndrome characteristic of duodenal diverticula. Rankin describes the condition as being either asymptomatic or capable of producing pain in some form. The pain may be of a dull aching type or dragging, boring sensation, referred to the right upper quadrant, midline or epigastrium. The onset of pain is usually gradual, occurring from one to four hours after meals, sometimes relief being achieved by alkalies and by food intake. Rankin believes that the symptoms may be due to inflammation or distention of the sac, from inflammation of surrounding structures or from pressure exerted by the distended sac upon adjacent tissues and organs. The symptoms may be those of some vague digestive discomfort following a gastric or duodenal, pancreatic or biliary, intestinal or colonic pattern.

F. W. Rankin and W. J. Martin[7] write that no typical chain of symptoms can be ascribed to this type of diverticulosis, and we are also in agreement that in unexplained abdominal complaints diverticulosis must be considered and ruled out.

Obviously then, the radiologist, surgeon and pathologist are all committed in making an accurate diagnosis of duodenal diverticula.

Assuming that the diagnosis has been made of duodenal diverticulum and other causes for the symptoms have been ruled out, we can further outline indications for operation by Morton's[2] classification: (A) Mechanical: (1) symptoms from local stasis, (2) symptoms from partial obstruction of the duodenum; (B) inflammatory: local diverticulitis with perforation, abscess or peritonitis; (C) neoplasm associated with diverticulum.

SUMMARY

1. A case of diverticulum of the third portion of the duodenum is presented.

2. Surgical approach through the transverse mesocolon, adequate mobilization of the duodenum, excising the sac and advisability of drainage are discussed.

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MASSIVE RECTAL HEMORRHAGE AS A DELAYED COMPLICATION OF APPENDECTOMY*

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MASSIVE rectal hemorrhage as a delayed complication of appendectomy is unusual. It is also uncommon for an individual three and one-half month's pregnancy to proceed to normal term and delivery following a right colectomy. We believe the case reported may explain the not too infrequent, residual, low right quadrant pain seen following appendectomies in which the pathologic conditions justified the operation.

Except in foreign literature little has been written recently regarding invagination of the appendiceal stump. Arguments both for and against have logic, but the present trend seems toward invagination. The case reported herein impresses us not as evidence against invagination of the appendiceal stump but points to the need for careful technic. The time involved and the greater incidence of infection due to additional manipulation of the contaminated stump by invagination is the strongest argument for those who do not invaginate. The time element in most cases seems insignificant, but the extra manipulation of the contaminated stump as an argument is sound.

Inversion is done for the following reason: The contaminated stump is removed from the peritoneal cavity, thereby covering the raw surface and lessening the likelihood of adhesions and subsequent intestinal obstruction. This is sufficient reason to warrant inversion, notwithstanding the contention of some that abscess formation is invited by so doing. This danger will be nullified by using small, plain catgut for stump ligature and larger chromic catgut, or non-absorbable suture, for purse-string. Abscess formation in such a procedure would cause little harm as it would empty easily into the cecum and heal promptly. We believe that invagination without ligation is too hazardous regardless of technic in placing the purse-string.

The following case report emphasizes the necessity of carefully placing the purse-string through the serosa only. Technically, the suture may include the muscularis, or all layers except the mucosa, but a "deep bite" is hazardous. We routinely invaginate the stump except when the cecum is thickened by an inflammatory process or not easily accessible for placing the purse-string.

CASE REPORT

Mrs. R. W. L., age twenty-four, was admitted to The Methodist Hospital, July 27, 1946. She was first seen in consultation while on the Obstetrical Service, as she was about three to three and one-half months pregnant. The following history was obtained with difficulty: Her mother died at an early age of pelvic cancer and her father died of tuberculosis, also at an early age. She had malaria several times as a child and an abortion eighteen months previously, with no evidence of infection. She had an appendectomy twelve months ago in an Army Hospital in Naples, after which convalescence was smooth except for persistent soreness in the right lower quadrant which continued to the time of her admission. The patient dated the onset of her present illness four weeks before admission. Following a laxative, she had a massive rectal hemorrhage and fainted. Rectal bleeding had occurred on several occasion since but was less alarming. She was admitted to a hospital elsewhere for blood transfusions and treatment following the initial hemorrhage. The blood ranged from bright to dark red, but was not tarry. She had a low grade fever and had not

felt well since the first hemorrhage. The patient had not realized any fever before the hemorrhage. The pain was not significant, but she still had soreness in the region of the appendectomy scar. Review of the other systems was irrelevant.

Upon physical examination the patient was very apprehensive and washed-out in appearance but not acutely ill. The examination was essentially negative except for the findings in the abdomen and pelvis. A well healed McBurney scar was present, above which there was protective rigidity and tenderness. No definite masses were felt. Pelvic examination revealed the uterus to be the size of a three and one-half months' pregnancy. Rectosigmoidoscopic examination was negative. Gastrointestinal x-ray studies, including barium enema, were reported to be negative.

Preoperative treatment consisted of several blood transfusions which corrected the anemia from a red blood count of 2,390,000 with a hemoglobin of 40 per cent to a red blood count of 4,040,000 with a hemoglobin of 76.6 per cent. Urinalysis, leukocyte and differential count, stool examination, hematocrit, platelet count, prothrombin time, bleeding and coagulation time, fragility test and total blood protein were reported within normal limits. For four days preceding surgery the patient was given large doses of sulfasuxadine, progesterone, ascorbic acid and Vitamin B complex, low residue, high caloric diet and saline colonic irrigations twice daily.

An exploratory laparotomy was advised, with the tentative diagnosis of carcinoma of the cecum. On the night before surgery 5 cc. of adrenal cortex was given intramuscularly. Under spinal anesthesia the entire abdomen was explored. The uterus was about the size of a three and one-half months' pregnancy. No pathologic disease was found except at the cecum. The tip of the cecum, from which the appendix had been removed, presented a roughened, indurated and puckered appearance. On palpation there was felt an intraluminal polypoid mass the size of an olive attached to the center of the indurated area. A right colectomy was done, followed by an end-to-side anastomosis. The incision was closed in layers using ooo interrupted silk suture. The immediate postoperative condition was good. During the course of surgery the patient received 1.000 cc. of blood.

Grossly, upon opening the cecum a polypoid mass was found as described in the surgical finding which measured 1 cm. in height and 1 cm. in diameter. At the base of the mass was a well defined triangular-shaped ulcer 1.5 cm. in length, extending through the mucosa to a depth of .3 cm. At a distance 1.5 cm. from the mass four additional discrete ulcerations were seen extending through the mucosa, each measuring approximately .6 by .4 cm. in length and width. Protruding from one of these ulcers was a piece of black suture material which on traction proved to circumscribe the polypoid mass by way of the ulcerations. A probe could be passed from this ulcer to the other three.

Microscopic examination showed ulceration of the mucosa with tunneling of the submucosa. The walls of the ulcerated tunnels were lined by inflammatory tissue of a non-specific character, composed chiefly of delicate fibroblastic tissue heavily infiltrated with lymphocytes and fibrin. The tissue was edematous and vascular. Some sections showed the suture material still to be in place in the submucosa and it was seen to be a cellular organic material, i.e., tendon.

The patient's convalescence was smooth and uneventful. The temperature remained below 99°F. For the first twenty-four hours following surgery nasal oxygen was given. No Wangensteen suction was used or indicated; 2 cc. of adrenal cortex was given every four hours for five doses and demerol, 50 mg., was given for pain. Progesterone was given in large doses during her further stay in the hospital. Intravenous fluids were given in adequate amounts during the first seventy-two hours. The diet progressed from fluids to a low residue diet on the sixth postoperative day. The patient was out of bed on the ninth postoperative day. The stools were loose and moved two to four times daily after the fifth day during a further hospital stay. The patient was discharged from the hospital well and happy, complaining of only a slight diarrhea. The patient has been seen in the office on several occasions since. The loose stools subsided gradually and by the sixth week she had returned to normal bowel habits. She delivered a full term baby normally on February 11, 1947.

CONCLUSION

This case is not offered as evidence against invagination, but is reported to indicate the need of greater care in placing

the purse-string when inversion of the appendiceal stump is practiced. This case also suggests the possibility . that an improperly placed purse-string may be the cause of vague abdominal pains following appendectomies. If a purse-string can cause such a condition as just reported, it is reasonable to assume that it can rather frequently result in similar pathologic disorders in a lesser degree. Personally, we still invaginate the appendiceal stump with few exceptions, namely, those in which the cecum is thickened and edematous and other cases in which the ceum is relatively inaccessible, making the placing of a purse-string technically difficult from a standpoint of doing so without contamination. We believe that a case of right colectomy in a three and one-half months' pregnant individual who went uneventfully to full term and normal delivery is so uncommon as to warrant reporting.

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THE sulfa drugs and antibiotics now play an important part in the treatment of peritonitis. However, they do not take the place of adequate surgery. Maintaining fluid balance is also an important factor and blood transfusions are valuable. Use of the Miller-Abbot tube in overcoming the obstruction and intestinal distention due to peritonitis is also an important factor in our recent successes in lowering the operative and postoperative mortality rates in these cases. However, good and adequate surgery is still as important as ever and must not be postponed simply because of the institution of chemotherapy and other methods. These measures supplement surgery but are not adequate substitutes for the scalpel as every competent surgeon knows. (*Richard A. Leonardo, M.D.*)

MORTON'S TOE—A NEUROMA

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MORTON'S metatarsalgia is a definite clinical entity with more or less constant basic symptoms and only slightly variable physical findings. It was described first by Thomas G. Morton in a report of fifteen cases of plantar metatarsalgia with pain localized in the fourth metatarsophalangeal articulation. He believed that it was due to neuralgia caused by the marked posterior position of the fifth metatarsophalangeal joint. Women wearing narrow and tight-fitting shoes caused the fifth metatarsal to be pressed against the head and neck of the fourth metatarsal; and the proximity of the digital branches of the external plantar nerve, under certain circumstances, are liable to be bruised by or perched between the fourth and fifth metatarsal. His advised treatment was complete excision of the irritable metatarsophalangeal joint and the surrounding soft parts. Morton's theory has been disproved by work done independently by Betts of Australia and McElvenny of Chicago and their work was confirmed by Baker and Kuhn of Durham, North Carolina and Bickle and Dockerty of Rochester, Minnesota.

The following two cases are being presented to add to the list of patients reported in the literature as being cured by the excision of the perineurofibroma which was present on the nerve medial to the fourth toe. This nerve is made up of the most lateral branch of the nerve plantaris medialis and a small branch from the nerve plantaris lateralis.

CASE REPORTS

CASE I. A thirty-four year old, white male was admitted to the orthopedic clinic of Station Hospital, Presque Isle, Maine, complaining of intermittent pains in the left metatarsal arch which radiated into the fourth toe and occasionally travelled posteriorly and up into the calf of the leg. The patient stated that discomfort in this foot began in 1924 and slowly increased in severity until 1938 at which time it became necessary to limit his activities and refrain from wearing high-heeled western boots. Some relief was first obtained by wearing metatarsal arch supports; however, this measure became progressively less effective.

Physical examination of this well developed, well nourished male was not remarkable except with reference to the present complaint. Examination of the left foot revealed no evidence of plantar calluses or verrucae. On manipulation the degree of mobility of the arch was normal and on weight-bearing the metatarsal arch showed no abnormalities. There was no palpable tumor present but deep pressure between the third and fourth metatarsal heads produced pain in the fourth toe. Roentgenograms of the foot were negative.

After removal of the perineural fibroma, measuring .8 by .4 cm., the patient was returned to duty one week postoperatively. Within a period of two weeks he was able to resume all forms of physical exercise and experienced no discomfort in wearing western riding boots.

CASE II. K. C., a thirty-one year old, well developed, well nourished, white female was admitted to the St. Francis Hospital on the surgical service of one of the authors, (E. W. M.). She complained of unilateral pains in the left foot about the third and fourth metatarsal heads which became severe after she walked some distance or stood for a long time. The pain would be relieved when the patient rested and removed the shoe but some residual soreness frequently remained. Surgical extirpation of the mass along with the nerve, as previously described, gave the patient immediate relief and at present she has not had any return of pain in this area.

ETIOLOGY

The etiology of the tumor of the fourth plantar digital nerve is not definitely clear.
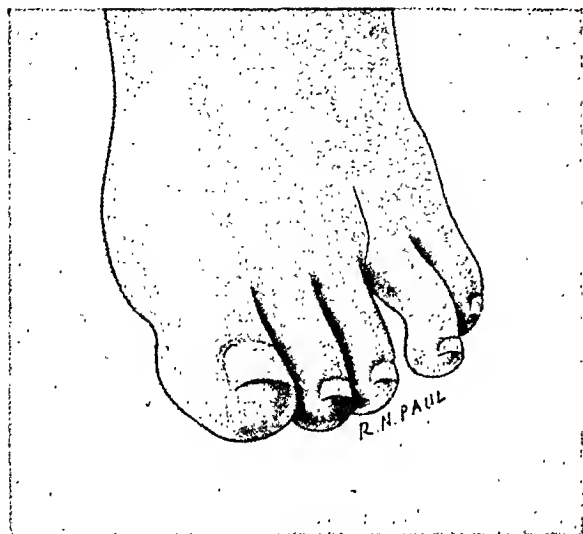
FIG. 1. Incisional approach for neuroma.

FIG. 2. Position of neuroma shown diagramatically.

It occurs in those who wear high-heeled and tight-fitting shoes but occasionally may be present in others. In Morton's classical paper he described the condition as being present in thirteen women out of fifteen patients seen and stated, "All the patients were surrounded not only by comforts but in most instances were accustomed to the luxuries of life." The frequency of sex occurrences reported by McElvenny and Kuhn were approximately of the same percentages. Although one of the two cases herein reported was a male, his condition also may be attributed to the high heel of the western shoe. The syndrome of metatarsalgia of this type definitely is due to the tumor of the plantar nerve and, as Bickle and Dockerty have stressed, this is probably caused by repeated trauma, usually due to the type of shoe worn.

DIAGNOSIS

Morton described the pain as being localized in the fourth metatarsal phalangeal articulation. McElvenny brought out the presence of a burning sensation present in this region in the early stages and the possibility of its being accompanied by paresthesia and numbness. As the condition progresses, there is usually a periodic, sharp, lancinating pain which develops as the patient is walking; it sometimes forces the patient to stop, remove the shoe and manipulate the foot. Also, the pain may radiate to the outer three toes or even up along the nerve to the calf of the leg. An area of tenderness is frequently present if pressure is placed just posterior to the third and fourth metatarsal heads. The two patients reported herein had what appeared to be good functioning feet, good metatarsal arches and had no calluses under the heads of the metatarsals.

TREATMENT AND PROGNOSIS

Under local or sodium pentothal anesthesia an incision 1½ inches long was made over the dorsum of the foot and extended into the web between the third and fourth toe. (Fig. 1.) This closely

resembles the incision made by McElvenny. Blunt dissection was used to expose the plantar nerve lying deep and slightly posterior to the head of the third and fourth metatarsal heads. (Fig. 2.) Complete removal of the perineural fibroma along with the nerve gives the patient complete relief. Microscopic examination of the growth revealed several nodules of fibrous tissue bound together by dense collagenous bands.

With the removal of this nerve, a small area of numbness will develop but the patient does not notice this fact unless asked about it. The prognosis is good and patients may resume all normal duties and go on wearing the type of shoe desired.

SUMMARY

Two cases of perineural fibroma are reported and the more recent literature has been reviewed. From the data of all these cases it is evident that Morton's metatarsalgia is not due to neuralgia but due to a perineural fibroma of the fourth digital nerve. It is a distinct clinical entity in itself and if the symptoms are severe, the growth should be removed surgically.

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New Instruments

CANCER TEACHING MODELS (PERMITTING PALPATION)*

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CANCER teaching today is inadequate. There is insufficient emphasis on early lesions. Open any cancer textbook and, for example, turn to carcinoma of the breast and you will observe photographs of ulceration, nipple retraction and peau d'orange. Similarly, photographs of "interesting" cases of carcinoma in other sites often show advanced stages of the disease. Early lesions, which are more difficult to photograph and also less spectacular, are seldom reproduced. This attention to advanced material may lead to an erroneous impression of the disease and give the physician a false and pessimistic viewpoint toward the curability of cancer.

When possible, to see and to palpate the early cancer lesion would be ideal. This method, however, is seldom used because there are not enough early cancer patients under observation; the patient and the students cannot always be brought together at the same time; and, aside from the inconvenience to the patient, there is the danger of spreading the disease by subjecting the patient to a long file of palpaters.

How could the present teaching methods be supplemented and the clinical method approximated? Moulages (models in wax) were available but were unsuited for palpation. To overcome this drawback the sculptor who had collaborated with Dickinson in the Birth Series, was consulted and the importance of palpation in the diagnosis of cancer was explained to him. It was agreed that rubber was the most desirable medium because of its varying consistency, resilience and durability. Our work on three-dimensional cancer teaching models was begun.

Previously, Dickinson and Fortuanato[1] had experimented along these lines as had Peluse[2] who reported in April, 1941 on casts made of otorhinolaryngologic specimens with translation into latex rubber. Woodland, Towson and Clark[3] in September, 1941 had similarly made casts of the spleen and heart.

Our objective has been not only to reproduce the specimen or organ in rubber but also to simulate as closely as possible the clinical conditions by reconstructing the part in its relationship to the body. This precluded direct casting from specimens.

Our technic consists of the following procedures: (1) A model of the desired part is sculptured in clay based on anatomic studies, operative procedures and clinical observation. This figure is modelled 10 to 15 per cent larger than life to allow for the usual shrinkage of rubber. (2) A plaster waste mold negative is made from the original. (3) From this the master cast, or positive, in plaster is obtained. (4) In turn a plaster piece mold negative is produced. In many of the detailed models this step is intricate as the piece mold is made up of many pieces which fit snugly into a mother mold. (5) The final translation into rubber is made by pouring natural latex, in which a flesh colored pigment is impregnated, into this piece mold, modifying the consistency of the latex so as to obtain the appropriate thickness and flexibility required for the

FIG. 1. Breast model demonstrating radical mastectomy. (Skin incision modified because of sculptural necessity.)

specific part. (6) The finished product which is hollow is filled with rubber flax, absorbent cotton or any material which will impart the desired differentiations in tissue consistency. (7) A more life-like appearance is obtained by retouching the finished model in color.

One model is the normal or the control. Various examples of neoplasms are superimposed upon the duplicates. For example, on the breast model (Fig. 1) a carcinoma is made palpable by imbedding plaster of paris within the breast; an adenofibroma is made palpable by inserting clay or

rubber; and a cyst, by inlaying a freely movable rubber ball filled with fluid. The attachment and fixation of the carcinoma is exhibited by the use of hard rubber which, when set, simulates a desmoplastic or scirrhous reaction on the part of the tissues. Skin dimpling, so frequently found in carcinoma of the breast upon gently compressing the neoplasm, may be represented by light adherence of the tumor to the skin.

On the gynecologic model (Fig. 2A to c) other procedures may be performed in addition to digital and speculum examinations.
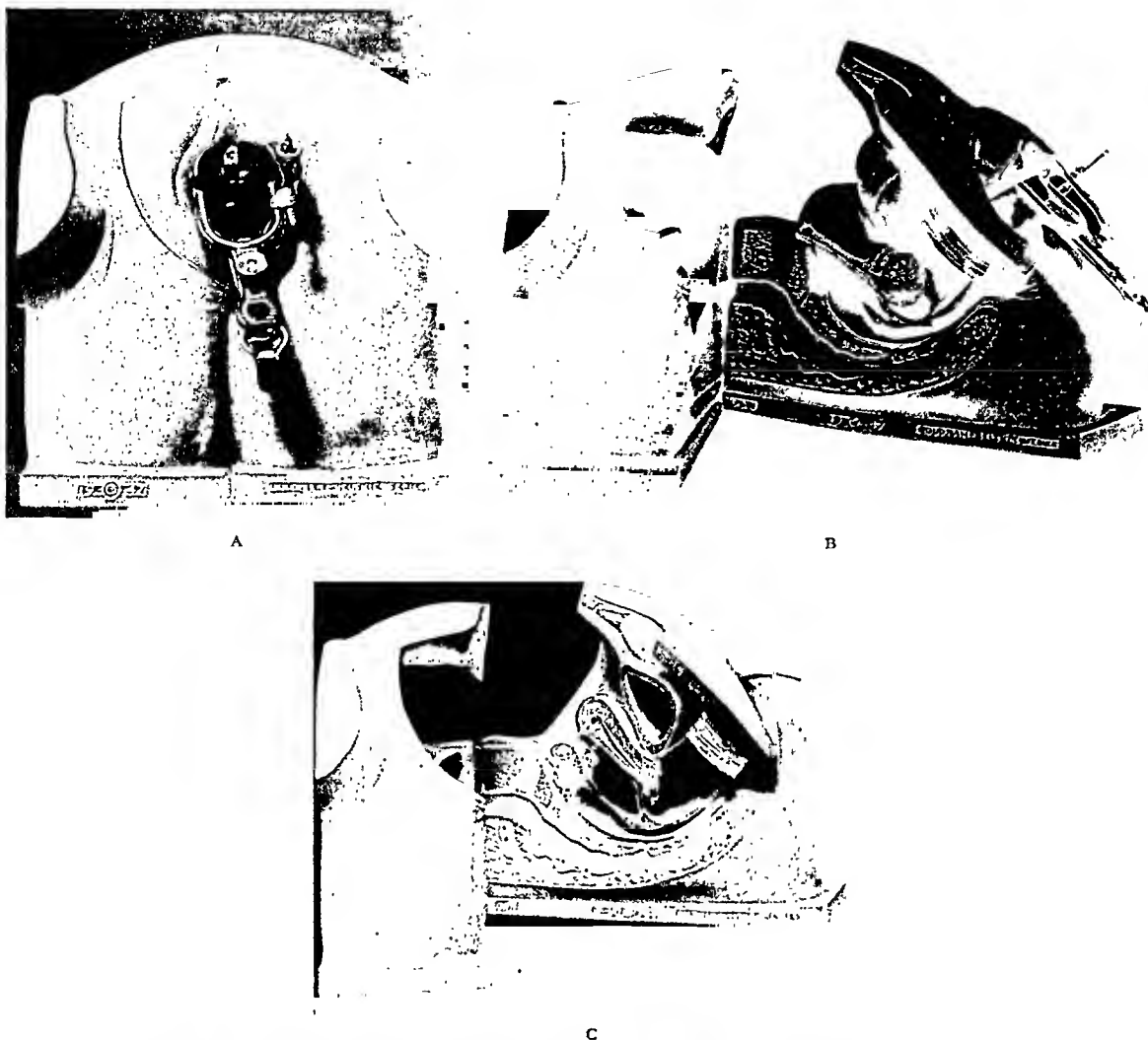
FIG. 2. A, gynecologic model; B, opened model shows carcinoma of the cervix; C, cervix, anterior right half of the uterine wall and right half of the bladder wall removed. Catheter shown in the bladder.
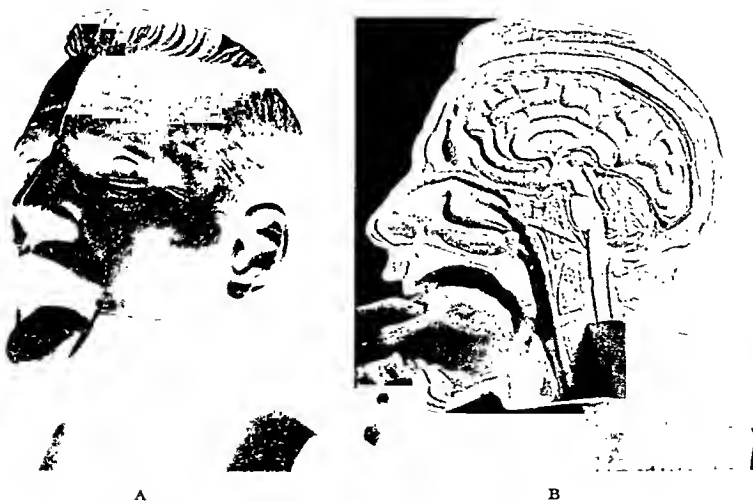
FIG. 3. A, head model; B, carcinoma of the tongue.

The cervices, being interchangeable, allow the demonstration of various types of pathologic lesions. From the abdominal side the relationship of the fundus of the uterus to the adnexa and pelvic cavity may be appreciated. One half of the anterior uterine wall may be removed as may a portion of the bladder wall (the bladder may be catheterized). In another gynecologic model it is possible to dilate the uterine canal and demonstrate the technic of dilatation and curettage preparatory to the insertion of radium.

On the head model (Fig. 3A and B) varied examinations may be practiced similar to those actually performed on a patient. A sagittal section exposes the anatomic structures and a removable half of the mandible allows study of the lingual and pharyngeal parts. Tongues are interchangeable.

In lesions not accessible to the fingers models will be constructed for endoscopic procedures, namely, bronchoscopy, gastroscopy, cystoscopy and sigmoidoscopy. Flexible armatures will be used to hold the "beings" in the position appropriate for these examinations. (Fig. 4.)

The possibilities of plastic materials are being explored as, for example, the use of a transparent plastic when vision of the underlying structures is desired.

Although these models were initiated primarily to teach early cancer, they can be utilized in other specialties. Their structural accuracy makes them suitable for anatomic study; surgical technics, obstetrical procedures and nursing methods may be demonstrated and practiced.

The teaching value of the models, like that of textbooks, lies in their availability. This requirement is met by the technic

FIG. 4. Carcinoma of the stomach.

which permits ease of duplication once the original is completed.

SUMMARY

Present cancer teaching methods fail to emphasize early lesions. A means of supplementing present teaching methods was desired.

Three dimensional rubber models, life-sized, fully colored and permitting palpation were introduced.

These models may be used in other fields.

The technic of casting permits ease of duplication.

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EFFICIENT, SMALL-SIZED, RING-HANDLED FINGER RETRACTORS

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THE uninterrupted and adequate exposure of the operative field is an essential in the performance of good surgery in such cases as lacerating wounds involving the tendons, nerves and blood vessels. It is obvious that the longer the procedure, the less perfect the exposure becomes. This is often the result of the assistant's fingers becoming tired of holding retractors that have handles which are uncomfortable and cannot be adequately controlled. In order to enable someone to stand and hold a retractor for twenty minutes to several hours it should rest easily in the hand and require a minimal amount of pressure to control the depth and tilt of the retractor end. Traction should be obtained by means other than through pressing against a flat, smooth handle held between the thumb and fingers. It is this strain of holding and pulling on an inadequate type of handle that causes the assistant to relax or change his grip frequently and this may occur just at the time the surgeon needs the best exposure. Furthermore, structures tend to slip away from some retractors unless the instruments have properly built edges and are held exactly in the proper position. Undue movement of the tired and cramped hand with change of position also interferes with maintenance of exposure. It is of great assistance to have the hand rest on the table in a fixed position. The ends of the retractors must be of varying depths and various shaped edges so as to control the slippery tendons readily and hold nerves and blood vessels without injury to them. Thus, blunt and sharp edged retractors with enough depth and inverted tips to hold the soft tissues adequately are required.

There was a great scarcity of surgical instruments in the United States during World War II and it seemed impossible for the surgeon to get manufacturers interested in making new apparatus as they were overworked trying to supply the instruments demanded by the armed forces.

In every hospital there are discarded or broken needle holders. It was while I was looking these over that the thought occurred to me that we could make use of them and thus supply some of the needed instruments. We flattened the shank, cut off the rachet lock and altered the ends by brazing on the type of retracting ends that I thought would be most useful in a set of retractors. Several sets of these retractors were made and soon became generally used by my associates and myself in such operations as repair of lacerated tendons, nerves and blood vessels of the extremities, excision of scars, correction of Dupuytren's contracture and so forth.

We have used these instruments for some time and have found that exposure could be obtained and maintained with far greater ease and that the assistant's hands would not become cramped and exhausted even though some of the operations lasted several hours. The advantage of these retractors is that the assistant can retract the fifth finger in the ring handle while the thumb and fingers adjust the retracting end to the required depth and angle. (Fig. 1.) Once this has been accomplished, he can rest the hand against the table
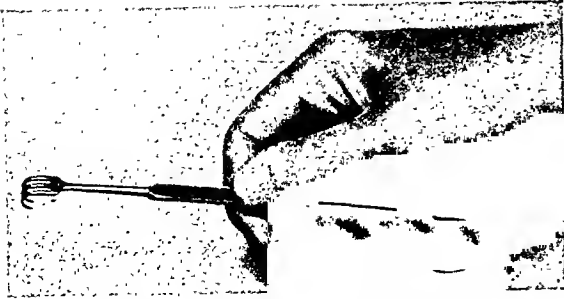
FIG. 1. Manner in which the retractors are held. Traction is obtained by the fifth finger and rotation by the thumb and fingers. The usual gripping and pulling with the thumb and fingers on a slippery, flat surface is thus avoided.

FIG. 2. Lateral view of the six retractors.

FIG. 3. The varied types of retractor ends.

and maintain the proper position without the strain of constant pulling pressure to obtain friction enough for traction and so forth on a smooth surface of the type of retractor which we used formerly. There are, therefore, two definite forces employed; the first one is that of the fifth finger pulling through the ring of the handle and the second one the rotating force through the thumb and fingers that hold the retracting edge in the desired position.

We had six retractors (Fig. 2) made 7 inches (17.8 cm.) in length, three of which had blunt edges with inverted ends. (Fig. 3.) Of these three, one was $1\frac{1}{16}$ inch (1.7 cm.) in depth and $\frac{1}{4}$ inch (0.6 cm.) wide, one $\frac{3}{8}$ by $\frac{3}{32}$ inch (1.0 by 0.2 cm.) and one $\frac{1}{4}$ by $\frac{1}{8}$ inch (0.6 by 0.3 cm.). These are the instruments that we use in the region of blood vessels, nerves and other tissues which one must be careful not to pierce. Of the remaining three, two have small, sharp teeth and one has larger, curved teeth. Of the first two, the teeth of one are $\frac{5}{8}$ inch (1.6 cm.)

in depth and $\frac{3}{16}$ inch (0.5 cm.) in width and of the other $\frac{1}{4}$ by $\frac{1}{8}$ inch (0.6 by 0.3 cm.). The third one has curved teeth $\frac{3}{8}$ inch (1.0 cm.) in width and $\frac{5}{32}$ inch (0.4 cm.) in depth. The sharp-toothed instruments are used on tissue which requires retraction without slipping and can withstand the sharp teeth without serious injury.

Surgeons who perform reconstructive operations on the extremities will find, I believe, that these retractors are most useful and that their assistants are grateful and more cooperative on account of the relief from cramping and exhaustion of the fingers.

COMBINATION BIVALVE AND SELF-RETAINING VAGINAL SPECULUM

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AT one time it occured to me that in some cases in which a bivalve vaginal speculum is used a combination with that of a self-retaining or weighted speculum might be of advantage. In like manner, when a weighted speculum is used, a combination with a bivalve blade might also have indications. I, therefore, have effected such a combination. (Fig. 1.)

I have found it helpful in doing the Rubin test, cauterization of the cervix, in curettage work when the uterus is situated on a high plane or in the presence of a long vagina or when the anterior vaginal wall is so redundant that an anterior retractor has to be employed to expose the cervix. It is of particular help when working without an assistant.

I have used a hand-made model of such a combined instrument for over twenty years and believe that it is of interest and usefulness to the profession.
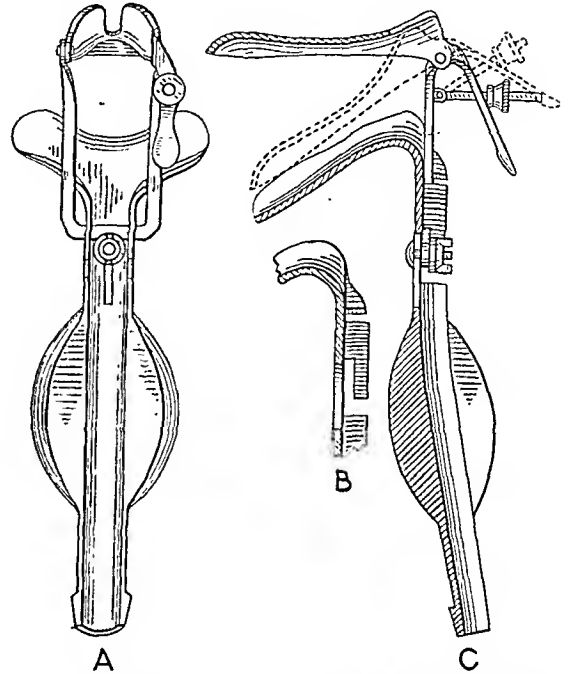
FIG. 1. A, front elevation of the speculum complete; B, vertical central sectional view of the same; C, transverse section of part of the shank throwing additional light on the removable and movable member in connection with the self-retaining part of the speculum.

Editorial

HOSPITAL BEDS! WHERE HAVE THEY GONE?

THE paucity of hospital beds, in spite of the demand for them, has been growing rapidly. In many communities it already has reached a level that adversely affects the practice of good medicine. Should it continue to gather momentum, as in the past few years, it threatens to cripple seriously our objective of adequate care of the sick. In the practice of surgery this situation is particularly disturbing, perhaps more so than in the medical branches of the profession.

Let us try to assess the factors and events which have led to this state of affairs, going back some thirty-five years when most people feared the hospital and would enter one only under the compulsion of a serious illness which demanded specialized hospital care. Up to that time most medical conditions, confinements and lesser surgical procedures were taken care of in the home.

The impact of World War I upon us together with advances in medical science had a salutary effect in popularizing hospitals both with the people and the medical profession. The former realized the need for specialized care obtainable most easily in the hospital and the latter found the hospital the most ready answer to their need of special equipment and services to meet the challenge of the day.

This, perhaps, was as it should be in raising the standard of medical care and applying efficiently the newer things in medicine. A few of the outstanding of these are liver in pernicious anemia, insulin in diabetes, heparin and dicumarol in thrombosis and then the great attack on tuberculosis, with an upward spiralling of the number of hospital beds all over the country. In the thirties the sulfonamides came and a little later, penicillin, to mention only a few of the newer aids in medicine which require greater hospital facilities. Added to these, the possibilities of surgical treatment have been growing steadily, covering an ever increasing field and requiring more and more special equipment and specialized technic much of it applicable only in the well equipped hospital.

World War II gave great impetus to our knowledge of much that we did not know before and has been the direct cause of a big increase in hospital beds and services in the United States and Canada.

Until ten years ago the situation seemed to be well in hand but for a few years before this, beginning with the depression in the early thirties, people gradually became more dissatisfied and political unrest was fostered by unemployment and poverty in the homes of many. Government agencies were set up to meet this catastrophe and gradually many of our people began to look upon this assistance as a right rather than as a privilege. The spark of socialization of medicine was thus

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fanned and an ever increasing body of opinion grew up to the effect that the state should shoulder more and more of the cost of maintenance of the health of the people. Political parties and agencies had to meet this changing order and were encouraged in their actions by the example set by countries across the seas.

Voluntary contributory insurance agencies grew up, some offering hospitalization and some health insurance. The Blue Cross extended its influence and in Canada we have two provincial governments giving free hospitalization to all its people.

This socialization of hospitalization and medical care accounts for the overcrowding of our hospitals more than any other factor. The situation is already serious but should a complete health and hospital coverage be given to all the people either by the government or by health insurance agencies, a still greater demand for hospital beds and services would soon develop.

It is easy to understand the attitude of the insured person who becomes ill with perhaps a trivial ailment which could well be taken care of in his home. He is entitled to *free* hospitalization; indeed he has been told so. Why stay at home with some added incidental expense? Why put the family out by the added duties entailed in his care? In this the physician may encourage him in that all facilities are readily available in the hospital and in addition he finds it much easier to attend a number of patients under one roof than in their respective homes.

Should it not be possible to have a minimal standard of disease under which no patient would be admitted to a hospital equipped for the handling of the more serious problems in medicine and surgery? The answer to the shortage of hospital beds which we most commonly hear is—build more hospitals! These cost a lot of money, are expensive to maintain and there is a limit to what the country can stand economically.

I think I can assert confidently that if a competent and neutral group of doctors were to assess the patients in an average general hospital at any time, perhaps 25 to 40 per cent could go home or be sent to a convalescent hospital, provided such were available, with reasonably competent management and supervision. The capital outlay in a convalescent hospital is much less than that of a general hospital and the maintenance cost per bed is infinitely less. The costly, highly trained personnel and specialized departments of hospitals would then be used more fully for the diagnosis and cure of disabilities for which they are designed.

Is not the time ripe for hospital boards, government agencies (who must supply the funds) and the medical profession to canvass this situation in the hope that convalescent homes or convalescent hospitals may be built or developed and operated in cooperation with hospitals? The needs of the sick thus may be met without lowering the standard of medical and surgical care to which they are entitled and the costs may be kept down to a figure that might be considered economically sound.

We surgeons may well study our patients and routine in the light of the known shortage of beds in hospitals equipped for major surgery. It is not unusual to find people who have had such operations as cholecystectomy, gastric resection, herniorrhaphy or other lesser procedures doing quite well postoperatively and still occupying a bed from two to three weeks after the operation. If convalescent hospitals were available, surely these active beds should be released much sooner for the needy on the waiting list, indeed, should not some go home sooner. Those of us who practice early postoperative ambulation have cut down the hospital days per patient significantly; but if convalescent beds were available, we could do a still better job.

GORDON S. FAHRNI, M.D.

Original Articles

SUMP DRAINAGE IN SUPRAPUBIC PROSTATECTOMY

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SUMP drainage has been used in industrial fields for many decades, but the principle has been applied to surgery only in recent years. The efficiency of sump drainage following prostatectomy has been shown to be highly effective due to rapid recovery of the patient. Stedman advocated the use of sump drainage of the bladder and introduced a motor suction pump. Ritter, McCarthy and others have advocated, designed and successfully used vesical sump drainage for several years. Babcock perfected and has successfully used the sump drain for intraperitoneal postoperative drainage. He observed that sump drains made of glass were effective, but there was always danger of breakage within the wound. The writer observed that vesical drains made of plated metal had a tendency to corrode when in contact with urine and were found to become very irritating to the tissue. Drains constructed of rubber, although ideal in some respects, were also found to be irritating to the freshly incised tissue. This irritation is undoubtedly due to a chemical reaction of the urine on the rubber. Considerable experimentation with drains constructed of lucite proved that such drains possessed many disadvantages and they were soon discarded. Babcock was the first to prove conclusively the advantages and successfully used the sump drain constructed of stainless steel for intraperitoneal drainage. It was following his observations that the stainless steel sump for postoperative vesical drainage, which has been so successfully used, was designed.

No inference is to be drawn by this contribution among the merits of suprapubic prostatectomy, perineal prostatectomy or transurethral resection. Each of these procedures has its own individual indications and surgical adherents. No attempt is made to compare these surgical procedures nor to compare their length of postoperative hospitalization. Nor is it intended to incite controversy as to the advisability of the different types of operation. This contribution is intended to be a description of sump drainage as it is used in suprapubic prostatectomy and the management of the patient having prostatic hyperplasia. There has been no selection of patients on whom sump drainage has been used, but rather it has been the selection of the proper sump drainage tube to be used on the individual patient. The principle of sump drainage is the same regardless of the size or length of the tube.

The speed with which wound healing by primary intention occurs, the complete comfort of the patient during its use, the decrease in postoperative complications and shortened hospitalization have been supporting factors for continued trial and error procedures and technics in the attempted perfection of vesical sump drainage. A stainless steel drain for vesical drainage was originally introduced in 1944. A subsequent model was presented in 1945. After repeated use an improved model of the drain was devised which is herein described. The sump drain is now employed routinely at the time of operation in all instances of cystotomy even when permanent suprapubic drainage is to be instituted later. Positive, effective postopera-
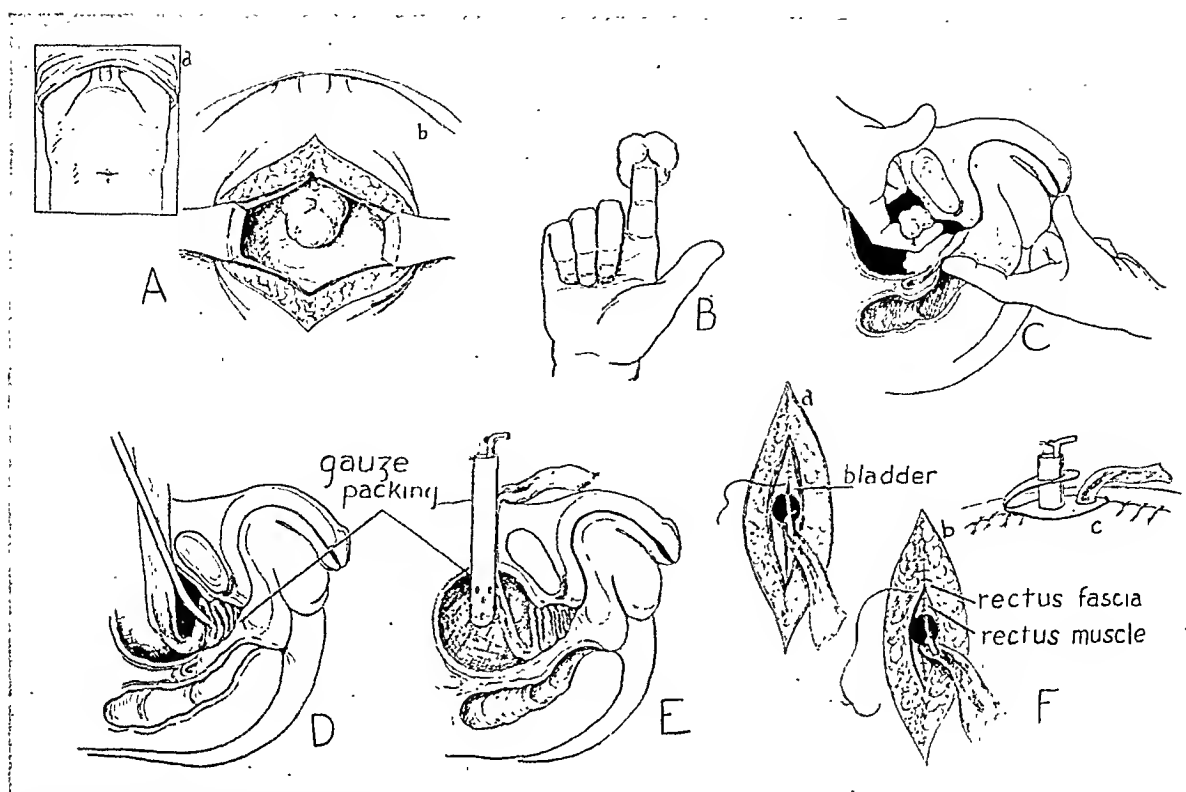
FIG. 1. Schematic drawing of the various steps of suprapubic prostatectomy. E, shows the relative position of the pack and the sump drain; F (a and b), the closure of the bladder and rectus fascia around the sump tube; F (c), the side view of the sump holder on the abdominal wall.

tive vesical drainage is assured with its use. (Fig. 1.)

It has been proven conclusively that vesical sump drainage materially shortens postoperative convalescence. In a comparative study of unselected cases it was found that the average postoperative convalescence was 32.6 days in one institution and 27.5 days in another institution when rubber tube drainage was used following suprapubic prostatectomy. When sump drainage was used, the postoperative hospital stay in uncomplicated cases is usually eleven to thirteen days. The shortest period of convalescence following prostatectomy in which sump drainage was used was eight days. In many cases cardiac or renal complications, so frequently encountered in patients with prostatic hypertrophy, impeded normal convalescence. For this reason many patients were forced to remain or chose to remain in the hospital after wound healing had occurred. As a result the average time of hospitalization for all patients was found to be 18.5 days. Inasmuch as the number of postoperative hospital days is of material economic importance, not only from the patient's standpoint but also from the standpoint of efficient hospital administration, it is a factor worthy of much consideration.

PREOPERATIVE CARE OF THE PROSTATIC PATIENT

It is believed that one of the most important factors in the management of the prostatic patient is meticulous preoperative care. In prostatic disease it is usual that the heart and kidneys show definite impairment by the time the patient is presented for surgery. In many instances it may be said that the heart and kidneys are tired and exhausted. A definite pathologic condition exists in the majority of instances. The age of the patient contributes to arteriosclerotic changes. These changes are proportionately just as great in the smaller blood vessels of the kidney as in

blood vessels of larger caliber. The filtration process of the kidney cells is hampered by the arteriosclerotic changes. Back pressure, created by the ever-present residual urine in varying amounts, causes further impairment of renal function. Increased nitrogen retention in the blood and a diminution of the excretory function, as revealed by phenolsulphonphthalein excretion, occurs as a result of this impairment. It has been shown that excretion of nitrogenous waste products is increased by the maintenance of a urinary output of 2,500 to 3,000 cc. daily. It is imperative to maintain it as high as can be tolerated by the patient. The heart frequently shows the effects of the retention of toxins by being weaker in tone than normal or independent cardiac impairment may exist. Electrocardiographic study is imperative to establish definitely the nature and extent of any cardiac impairment. Every proven cardiac impairment should be subjected to treatment before surgery is contemplated. Repeated determinations of blood urea nitrogen and phenolsulphonphthalein elimination should be made until a return to normal or safe levels occurs. Such levels occur following vesical drainage which is continued for varying lengths of time.

Such drainage should be maintained either by a suprapubic tube or by a retained urethral catheter. Use of the indwelling urethral catheter is preferred inasmuch as it permits greater freedom of action by permitting the patient to be ambulatory. Continuous preoperative bladder drainage by retained catheter may be employed successfully in the majority of instances without fear of infection if diligent, meticulous care of the catheter and the patient is maintained. The exceptional occurrence of continuous, severe, intravesical hemorrhage, the presence of large vesical calculi, severe vesical inflammation or, in certain instances, subcervical or posterior commissural hypertrophy may prevent satisfactory use of the retained catheter. Any condition causing spastic irritability of the bladder prevents use of the retained

catheter and requires cystotomy for preliminary drainage. It is believed that long continued preoperative drainage by urethral catheter, even for a period of months in some instances if necessary, is essential to insure postoperative recovery. In those instances of long continued drainage the pH of the urine is maintained at a low level by oral administration of sodium acid phosfate. An acid urine prevents the collection of urinary salts on the catheter and lessens the possibility of infection of the bladder with Bacillus proteus. Stabilization of the blood urea nitrogen at normal levels and elevation of the percentage of excretion of phenolsulphonphthalein are imperative factors of adequate preoperative management. An unsatisfactory condition exists when the blood urea nitrogen levels are normal but the phenolsulphonphthalein levels of excretion are very low. It is obvious that the nearer the results of these tests approach normal levels the shorter the postoperative convalescence and the lower the percentage of operative mortality. Operative accidents, such as cardiac failure, apoplexy, thrombosis or embolus, occur occasionally in spite of the fact that every possible precaution has been taken before operation to prevent their occurrence.

Fasting blood sugar determination should always be done during the preliminary survey of the patient. It has been surprising to learn the number of elderly men who suffer not only with prostatism but also with diabetes. A proper diabetic regimen to establish normal blood sugar levels should be instituted before surgery is contemplated. In a recent survey of one hundred consecutive individuals subjected to prostatectomy it was learned preoperatively that nine patients had diabetes without their knowledge.

It is believed that indiscriminate haste in the preoperative preparation of the patient has and will account for needlessly high mortality in prostatectomy. In the early days of prostatic surgery the mortality was high, very high, but surgeons

of that time did not have at their command the advantages of modern laboratory methods. Nor did they have the knowledge of the deleterious effects of partial or complete urinary retention as the factors producing high blood urea nitrogen retention and excessively low phenolsulphonphthalein excretion. In direct proportion with the progress made in estimating and establishing the patient's preoperative condition by routine tests the mortality rate in prostatic surgery has declined. At the present time it is a conceded practice that the patient be placed in the best possible physical condition before surgery is performed. If the patient's condition is such that his tests do not indicate a return to normal levels, operation is deferred.

It is generally conceded that the one-stage suprapubic prostatectomy, following use of the retained catheter, is more easily performed than the two-stage procedure. The tissues are more readily pliable, the healing of the wound is more secure and a shorter postoperative hospitalization is usual. It has been proven conclusively that sump drainage of the bladder following the one-stage procedure has decreased still further postoperative hospitalization.

TECHNIC

Anesthesia. The selection and use of the proper anesthesia is considered to be a very important factor in prostatic surgery. Each patient should be judged individually as to the type or kind of anesthesia to be used. It is a well established fact that no one type of anesthesia may be used routinely in prostatic patients. It has been demonstrated repeatedly that elderly prostatic patients tolerate poorly a sudden fall in blood pressure during any type of anesthesia, particularly protracted general anesthesia. Spinal anesthesia, using 75 to 80 mg. procaine 10 per cent, administered in the fourth interspace, has been found to be most ideal in the majority of instances. The anesthesia attained by use of this drug is rapid and the effects of such a

dosage continue for thirty to forty-five minutes, more than sufficient time to perform the average prostatectomy. The level of anesthesia should be controlled so that it does not extend higher than the level of the umbilicus. It has also been found that the postoperative reaction to surgery is better when the preoperative blood pressure level can be maintained at all times. One great disadvantage of spinal anesthesia is an untoward drop of blood pressure in the presence of cardiac impairment or in hypertension. It has been repeatedly shown that a fall of blood pressure, when spinal anesthesia is used, is frequently followed by cardiac or cerebral embarrassment which may be fatal or leave permanent damage. Any decline of preoperative blood pressure levels may be combatted by intramuscular injection of such pressor substances as ephedrine 25 to 50 mg. or methadrine 10 to 20 mg. The amount of the drug to be given is dependent on the blood pressure levels or the degree of hypertension. Further efforts to maintain preoperative blood pressure levels are made by intravenous administration of glucose in saline solution given immediately following administration of the anesthetic. It has also been found that oxygen, 100 per cent by inhalation, is another adjunct in the maintainance of preoperative blood pressure levels. Caudal-trans-sacral block, using 50 to 60 cc. procaine 1 per cent with local infiltration of the abdominal wall, has proved to be of merit in those instances in which a fall in blood pressure would be especially detrimental to the patient. It is believed that either spinal anesthesia or caudal-trans-sacral block permit a rapid "come-back" so essential to patients if morbidity is to be a considered factor of convalescence.

Intravenous Therapy. The percentage of hemoglobin is used as an index for the preoperative administration of whole blood. It is believed that any individual having marked secondary anemia or who is anemic following profuse intravesical hemorrhage should receive repeated transfusions of

whole blood to compensate for the blood loss during the preoperative preparation.

It is further believed that administration of koagamin, a compound of oxalic acid and other di-carboxylic acids, aids materially in increasing coagulation time. The drug has been routinely administered one hour before operation and has been given simultaneously in 2 cc. doses both intravenously and intramuscularly. The drug has again been given in 3 cc. doses intravenously and intramuscularly immediately after operation and repeated in such dosage after three hours. The drug has been further employed in 3 cc. doses intravenously and intramuscularly administered prior to removal of the pack from the prostatic cavity. It has been found that intravenous administration of 5 per cent glucose in isotonic saline solution begun immediately following administration of the anesthetic, except in diabetics, aids materially in maintaining preoperative blood pressure levels. In the presence of diabetes isotonic saline solution without glucose should be administered. The calculated dosage of glucose, having been computed by an internist, should be given intravenously before the patient is taken to the operating room. Intravenous administration of isotonic saline or glucose in saline solution combats surgical shock, prevents excessive fall in blood pressure and promotes continuous renal function so vitally necessary for speedy recovery.

It has been established that a transfusion of 500 cc. of whole, matched, compatible blood should be administered immediately after operation. The general condition of the patient, loss of blood and evidence of shock has governed the further use of transfusions.

Preoperative Filling of the Bladder. The question of whether or not to fill the bladder immediately prior to operation is considered to be an individual problem with each surgeon. It is believed that filling of the bladder immediately before operation is to be preferred. Boric acid solution is employed routinely for this

procedure. Inadvertent opening of the peritoneum is obviated and the proper site of incision in the bladder wall is more readily assured. Retraction of the peritoneum and other tissue is more readily accomplished when the bladder is full than when it is empty. The one great disadvantage to preoperative filling of the bladder is the soiling of the freshly incised tissues and the surrounding surgical linen by the intravesical fluid. This disadvantage may be eliminated by prompt suction withdrawal of the bladder contents by a suction tube introduced into the bladder through the incision. The suction tube regularly employed is of original design and is connected directly to the standard operating room suction apparatus. The suction tube is so constructed that large openings at the distal end permit rapid evacuation of the fluid from the bladder. (Fig. 2.) The air necessary for proper suction is admitted by a series of vent holes in the upper extremity of the tube. There is no danger of injury to the mucous membrane and the fluid contents of the bladder are rapidly evacuated.

Speed of Procedure. It is contended that rapid, efficient operative procedures are highly essential factors in prostatic surgery. The elderly patient with a large prostate who has had a definite residual for months and who has impaired renal and cardiac function is far from a first class surgical risk. Surgery should be done rapidly, with the least possible trauma and without shock, to provide the greatest degree of safety. It has been repeatedly shown that these elderly patients, when subjected to excessive trauma or surgical shock, recover slowly and are always subject to intercurrent complications. A well established technic of surgical procedure, speedily yet efficiently applied, is a factor of prime importance.

Incision. It is contended that the smallest possible incision for efficient work, both in the skin and fascia and in the bladder, is to be preferred. Contrary to the general belief that a long incision will
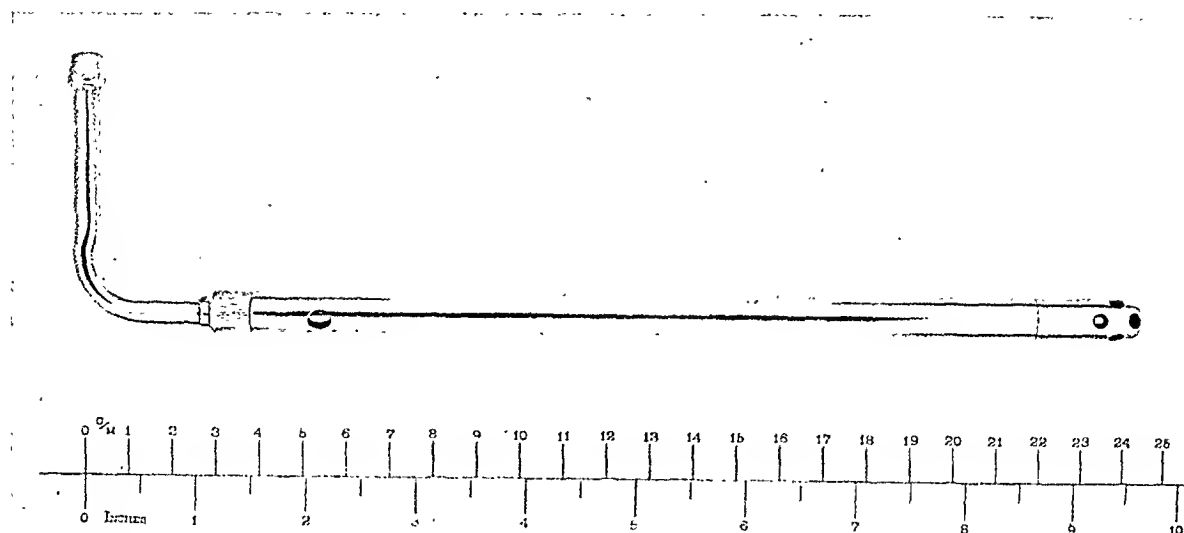
FIG. 2. Author's design of suction apparatus used in the operating room for rapid evacuation of the bladder. The apparatus is so constructed that it is impossible to "suck up" the mucous membrane or loose tissue, yet the inner or delivery tube is of such caliber as to evacuate the bladder rapidly. It is ⅜ inch in diameter and may be inserted into the bladder through a small incision without danger of trauma to the mucosa.

heal as rapidly as a short one suprapubic cystotomy incisions are frequently infected, may break down and become necrotic. This is particularly true when rubber tube drainage is used. There has been only one wound infection during the years of use of the sump drain. It is further concluded that a midline linear incision in the skin and fascia, not more than 2 to 2½ inches in length, is most satisfactory. The incision, started at the upper most level of the symphysis pubis, is continued upward toward the umbilicus. In depth the incision is continued through the subcutaneous tissue and sheath of the rectus muscle without dissection. All bleeding points are ligated before continuing. The fibers of the rectus muscle are separated longitudinally. The reflection of the peritoneum over the bladder is pushed upward along the midline toward the umbilicus. Care is exercised to avoid unnecessary reflection of the tissues on the lateral walls of the bladder. It has been found that it is not necessary to disturb those tissues lying between the posterior surface of the symphysis and the bladder wall. The incision into the bladder is made sufficiently large to admit the index finger readily. The bladder is evacuated of its fluid contents by suction

immediately after incision. Rapid suction prevents the wound from being flushed with the fluid used for distention of the viscus. A suture of heavy braided silk or chromic catgut is applied at each extremity of the incision in the bladder to prevent tearing of the incised bladder wound during enucleation. These sutures are of sufficient length to be used as retractors. The small incision in the bladder may be readily extended should more exposure become necessary. Seldom is such a procedure required.

Enucleation of the Prostate. The enucleation of the prostate is best accomplished by the index finger rather than by mechanical contrivance. An assistant elevates and steadies the prostate by placing a finger in the rectum. The individual lobes of the prostate are enucleated and are removed through the small incision in the bladder. Enucleation may be begun by incision of the mucous membrane overlying the most prominent projecting portion of the prostatic mass or by splitting the mucosa between the clefts of the hypertrophied lateral lobes at the vertex of the vesical orifice. The plexus of Santorini lies at the vertex of the vesical orifice. Considerable hemorrhage may result from
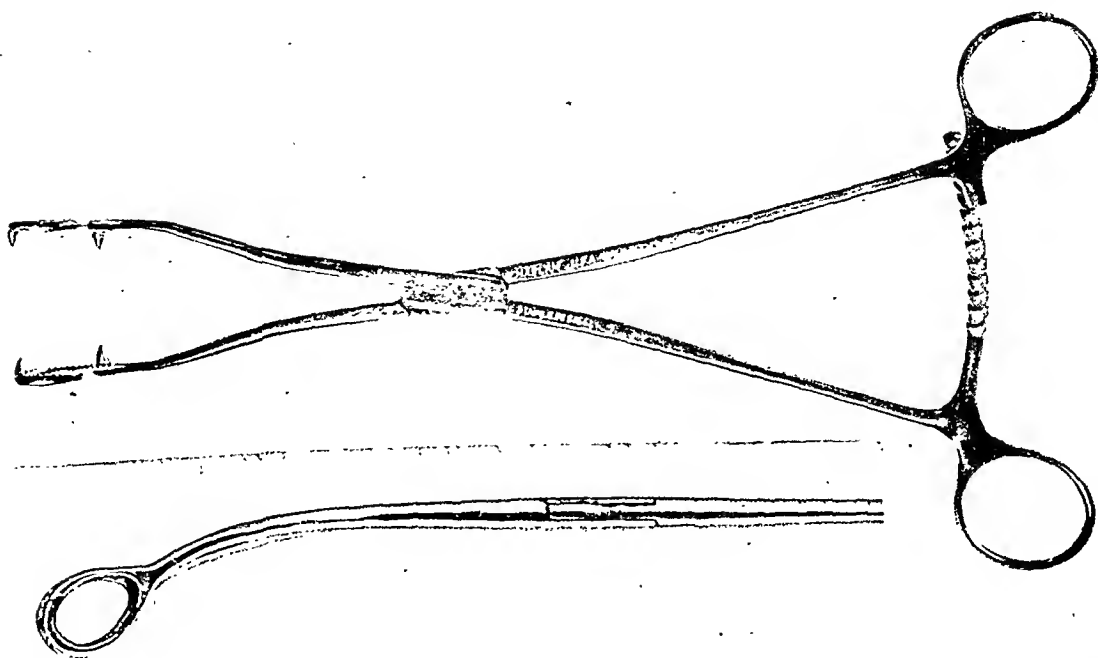
FIG. 3. Prostatic forceps of original design. The long ratchet at the hilt permits grasping of a large lobe of the prostatic tissue by the curved, toothed, circular jaws of the instrument. The curve is such as to permit the operator's fingers to pass behind the instrument without interference in enucleating the prostatic lobes in the deep urethra.

inadvertant injury to the plexus by the enucleating finger. The enucleation is accomplished by sweeping the index finger along the line of cleavage until the hyperplastic tissue is entirely detached from the capsule of the prostate.

Some difficulty in enucleation is always encountered in the area of the verumontanum. This area is the most distant point which the enucleating finger endeavors to reach. Such difficulty of enucleation may be eased considerably by elevation of the prostate with forceps. Considerable success in this difficult maneuver has been afforded by an especially devised forceps of original design. (Fig. 3.) These forceps have sufficient spread that the partially enucleated tissue may be grasped firmly and are of such a shape that they do not interfere with manipulation of the enucleating finger. The free edge of the enucleated prostatic lobe is grasped and upward traction is made while the enucleating finger passes beneath the lobe to free the distal margin.

Following removal of the hyperplastic

tissue, the orifice of the prostatic cavity is visually examined. Any remaining tabs of tissue are removed leaving the prostatic capsule smooth.

The immediate hemorrhage is controlled by compression. A gauze sponge saturated with hot saline solution and held in spongeforceps is inserted into the prostatic cavity. The sponge is removed after several minutes of compression and the cavity packed with a 2 inch plain gauze pack. Gauze packing for the control of hemorrhage is to be preferred to the use of the Pilcher or Hagner bag when sump drainage is used. A short nosed catheter with a 75 cc. balloon has been satisfactorily used but the gauze pack is preferred. The pack is removed in stages twenty-four to forty-eight hours following operation. It has been demonstrated that considerable bleeding may continue in some instances during the entire time the pack is *in situ*, but that the bleeding will abate quickly following complete removal of the pack permitting contraction of the vesical orifice. It has been advocated by others that
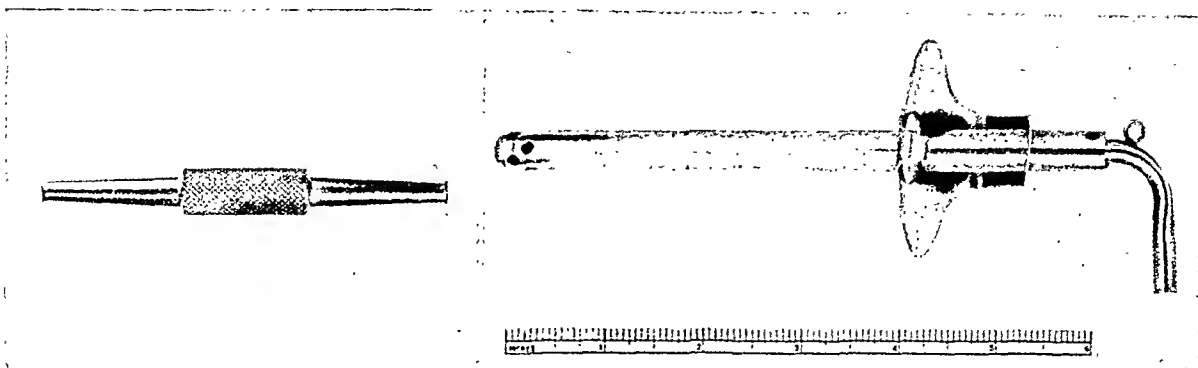
Fig. 4. Small tapered metal tube used in operating room to connect vesical sump drain to operating room suction apparatus in order to maintain a dry field during closure.

Fig. 5. Author's design of sump drain which is made of stainless steel, 6 inches long, 10 mm. in diameter, with walls 0.015 inch in thickness. The apertures at the tip are ⅛ inch in diameter and are adequate to evacuate vesical contents. The holder, which is movable, may be adjusted so that the sump may be held at any desired depth within the bladder. The sump may be rotated but cannot be raised or lowered without bringing the two holes of the device into perfect alignment.

closure of the bladder without packing in the prostatic cavity may be done safely. The procedure of not packing the prostatic cavity has not been attempted as yet with sump drainage. It is believed that it could not be done in every instance but could be done occasionally without detrimental results.

Closure. The sump tube is inserted into the bladder immediately after the prostatic cavity is packed. Connection of the sump to the suction apparatus with which the operating room is ordinarily equipped is made by a tapered metal connecting tip having a large caliber. (Fig. 4.) Continuous suction during closure assures a dry operative field as any mixture of blood and urine is immediately withdrawn. The bladder incision is closed loosely around the sump tube and the pack with interrupted chromic catgut sutures. It is imperative in the closure of the wound that the sump tube be introduced and maintained in a true vertical position. The sump tube holder to be applied later must lie on the anterior abdominal wall in such a fashion as to maintain a vertical position of the sump. If the wound is closed with the sump at an angle, continuous pressure will be made on the bladder wall by the end of the sump or pressure on the abdomen will be made by the thin edge of the holder.

Following insertion of the sump tube and closure of the bladder, the fibers of the rectus muscle are also loosely approximated with chromic catgut sutures. The cut edges of the fascia are approximated with interrupted alloy steel sutures. The incised skin edges are also approximated with alloy steel sutures. It has been found by numerous investigators that steel alloy sutures are not irritating to the tissue and lessen the possibility of infection. The danger of incisional hernia is reduced and the patient may be permitted out of bed more quickly when alloy sutures are used.

Drainage. The sump drain is considered to be superior to rubber tube drainage of the bladder in the postoperative management of suprapubic prostatectomy. In only one instance in which sump drainage has been employed has infection or necrosis of the wound occurred. Such a complication is of common occurrence when rubber tube drainage is employed. It is believed that the sump tube having the greatest utility is one made of alloy or rustless steel of 0.015 inch in thickness. (Fig. 5.) Tubes of varying sizes may be used but experience has shown that the most serviceable for immediate postoperative drainage is a tube 10 mm. in diameter and 6 inches in length. This has been found to be large enough for efficient drainage. A tube ⅝ inch in diam-

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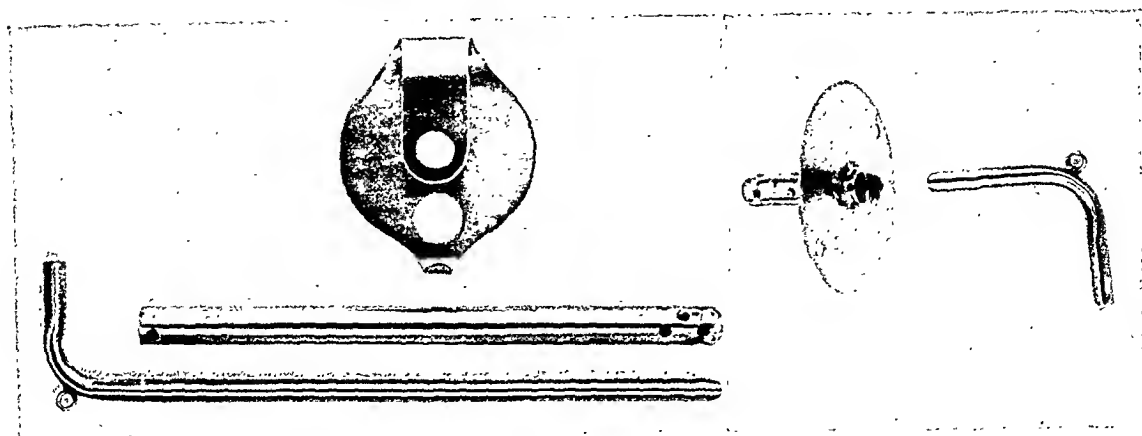
FIG. 6. Shows component parts of the sump drain. All parts are readily demountable to permit cleaning and sterilization yet are assembled easily and quickly in the operating room.

FIG. 7. Small, short drain used in conjunction with postoperative catheter drainage. This drain is held *in situ* with adhesive straps across plate beneath the surgical dressings.

eter was originally suggested but was found to be unnecessarily large. These sump tubes are so constructed that a series of ⅛ inch holes ¼ inch apart are placed ½ inch from the rounded or distal end of the tube. A second series of like apertures are placed ⅜ inch above the first series of holes. The central or suction tube is ¼ inch in diameter and is of sufficient length to rest on the floor of the interior of the sump tube. This ¼ inch diameter tube has been shown to be most efficient. There are two notches on the end of the suction tube which afford an aperture for constant suction. It has been learned by experience that a small central or suction tube is inefficient. Small tubes have a tendency to become encrusted quickly with urinary salts and become clogged or easily closed by blood and blood clots. It is imperative that the glass connecting tip used in connecting the sump with the exhaust bottle at the bedside be a square cut tube rather than the glass tapered tube so frequently employed. The tapered tube tends to clog too readily.

Maintenance of the sump at any desired depth within the bladder has been a difficult problem. It was formerly recommended that the tube be supported by a loop of surgical tape. While this method was satisfactory in the majority of instances, the sump would occasionally slip

out of the bladder. Although not serious, such an accident necessitated undesired manipulation of the wound in order to replace the tube. Following considerable experimentation, a contrivance was devised capable of offering positive support to the sump at any depth desired within the bladder. The contrivance consists of two discs, one large and one small, made from a single piece of stainless alloy steel. (Fig. 6.) In each disc is a hole accurately bored to the size of the individual sump tube. The metal of the intervening bridge is bent so that the two holes are nearly in true alignment. A sump tube introduced through the two holes should be held in the same fashion as a transom rod. The two holes in the pieces of metal must be brought into absolute true alignment for the sump tube either to be raised or lowered but may be readily turned at all times in a clockwise or counterclockwise direction. A second but larger aperture in the base plate of this contrivance permits the end of the pack to be brought through, allowing the support to rest squarely on the abdominal wall.

It is customary to remove the large 10 mm. sump tube at the time of removal of the pack, twenty-four to forty-eight hours after operation, if no bleeding occurs. An indwelling urethral catheter is instituted after twenty-four hours of clear drainage and a small, short, sump drain is inserted

FIG. 8. Shows a motor suction pump, standard hospital equipment for individual use. It utilizes 110 volts, 60 cycles, A. C. current, is fully encased and is self-lubricating. Amount of vacuum required is regulated by small upright valve on frame of casting.

removed and the patient instructed to void every hour.

THE MOTOR SUCTION PUMP

The motor suction pump routinely used in sump drainage is self-starting, non-reversable and noiseless, operating only on alternating current of 110 volts, 60 cycles. The motor and all moving parts are fully encased and properly insulated to prevent accident or shock at the bedside. (Fig. 8.) The motor, reduction gear and pump are self-lubricating and will run continuously without attention for a period of approximately two weeks. The motor operates at a set speed exerting a continuous negative pressure in the reservoir. This negative pressure is in turn exerted at the distal end

FIG. 9. Complete assembly of motor-pump unit. It is imperative that the capacity of the drainage bottle be greater than the daily urine excretion. Damage to motor unit may occur if urine is drawn into its mechanism.

into the wound. (Fig. 7.) This tube is 1 inch in length and is placed in the wound beneath the surgical dressings. The patient is then permitted out of bed in a chair. Damage to the wound will not occur if the surgical dressing becomes slightly damp at this time. This small sump is permitted to remain until all suprapubic leakage has ceased. The urethral catheter is permitted to drain continuously until the wound in the bladder is firm. The catheter is then

of the suction tube within the sump drain. The total vacuum capacity of the pump is not used but a control valve is regulated so that a continual minimum vacuum is used. The creation of excessive vacuum would cause trauma to the mucous membrane of the bladder. It is imperative that the drainage bottle used be of such capacity as to be greater than the urinary output of twelve hours. (Fig. 9.) Fluid must not be permitted to be drawn into the pump.

IMMEDIATE POSTOPERATIVE CARE

Immediate postoperative care has been shown to be an important factor in speedy recovery. The sump drain must be rotated at least twice a day to prevent "freezing" to the mucous membrance. For efficient drainage the suction tubes must be open at all times. It is believed that individual nursing personnel especially trained in the management of postoperative prostatic surgery constitutes one of the greatest aids in the recovery of these patients. Constant attention to detail and the comfort of the patient, by an efficient nurse who is capable of recognition of the early onset of any complication greatly eliminates some of the hazards of prostatic surgery.

Immediate postoperative transfusion of compatible whole blood combats shock and blood loss and is routinely employed. The need of subsequent transfusion is guided by the general condition of the patient and his reaction to surgery. Estimation of the Rh factor is important. Only that blood which is compatible and of the same Rh factor should be used. Transfusion reactions should be avoided.

Profuse secondary hemorrhage following removal of the pack occasionally occurs and is considered to be due to the marked arteriosclerosis which is so frequently manifest in these patients. Such a hemorrhage may be severe and may quickly reach dangerous proportions. Such a complication necessitates immediate compression of the prostatic bed, transfusions of whole blood and administration of supporting measures. It has been found that such a secondary hemorrhage may be controlled effectively by the introduction of a Foley catheter into the bladder through the urethra. The balloon having a capacity of 75 cc. is recommended and may be filled to any desired amount depending on the relative size of the cavity. Following introduction, the balloon is distended and gentle but continuous traction is made on the catheter for a period of one to two hours. The tension or traction on the catheter may then be gradually released. The distending

medium of the balloon is then gradually reduced if no further bleeding occurs. The catheter may be "tied in" and permitted to drain. Excessive traction is never exerted nor is traction continued for long periods of time.

DISADVANTAGES OF THE SUMP

Sump drainage may only be accomplished and successfully operated by mechanical contrivances which must be understood by the nursing and intern staff.

The sump must be rotated at least twice a day to free the bladder mucosa from the apertures of the drain. If the mucosa is permitted to enter the holes of the sump the tube will "freeze" in position. If such a condition is permitted to occur, not only will the efficiency of the sump be impaired but it can only be removed by force. Such removal is done with considerable pain and discomfort to the patient. Forceful removal of the sump is accompanied with considerable bleeding as the mucous membrane, which has entered the holes of the tube is sheared off.

Constant pain may be experienced by the patient if the sump is introduced too deeply into the bladder in such a fashion as to permit the tube to rest or presss on the trigone. Such discomfort may be eliminated by elevation of the tube from the floor of the bladder.

ADVANTAGES OF SUMP DRAINAGE

The patient is kept dry continuously. The surgical dressing and bed clothing are never soiled or wet. The danger of pneumonia is materially lessened. Ulceration of the skin of the buttocks or abdomen by contact with urine is prevented. Healing occurs by primary intention due to the fact that the wound is continuously dry. Postoperative hospitalization is materially lessened. It has been found that the average length of postoperative hospitalization was 32.6 days when rubber tube drainage was used as compared with an average of 18.5 days when sump drainage was used.

The metal sump is less irritating to the

freshly incised tissue than is a rubber tube. There is no chance for irritating or infected urine to follow along the fascial planes with ultimate necrosis of the wound so commonly observed when rubber tubing is used. It has been repeatedly demonstrated that rustless steel does not irritate the tissue nor cause the tissue to show localized necrosis of the incised wound as is frequently evident when rubber tube drainage is used.

The sump may be removed readily for evacuation of clots from the bladder in the event of hemorrhage from the prostatic bed. Reinsertion of the metal tube may be readily accomplished without pain or discomfort to the patient.

Due to the constant evacuation of the bladder contents there is little chance of retrograde filling of the ureters. The occurrence of pyelonephritis has apparently been reduced. Only one instance of pyelonephritis has been observed in seven years of repeated use of the sump drain. This instance occurred in a debilitated old gentleman who was known to have chronic leukemia. The tissue removed at operation showed leukemic infiltration; the blood pic-

ture changed rapidly following operation. The man died of pyelonephritis in spite of all measures to control it.

SUMMARY

1. A metal sump drain for vesical drainage is presented. A new method of holding the sump at a desired depth within the vesical cavity is described.

2. The contrasting figures of hospitalization between suprapubic rubber tube drainage and sump drainage have been shown. Postoperative hospitalization was reduced from 32.6 days to an average of 18.5 days when sump drainage was used.

3. The suprapubic wound heals rapidly due to the fact that the wound is continuously dry. Decubitus ulcerations do not occur as the bed linen is dry.

4. The occurrence of pyelonephritis and pneumonia as postoperative complications has apparently been reduced.

ECTOPIC PREGNANCY*

II. WITH SPECIAL REFERENCE TO ABDOMINAL PREGNANCY

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TREATMENT

Occasionally the aberrant ovum dies at the site of its nidation, or an unobtrusive rupture or abortion occurs, with subsequent absorption of the products of gestation and spontaneous recovery. This kind of atypical ectopic pregnancy goes untreated either because the symptoms were so mild that the woman did not seek medical counsel or the physician dismissed the patient for lack of signs. Every case diagnosed as ectopic gestation requires surgical treatment.

The following sections on preoperative treatment, time of operation, anesthesia, transfusion, management of blood and blood clots and postoperative treatment apply in some measure to all types of ectopic gestation.

Preoperative treatment depends upon the condition of the patient at the time the physician first sees her. If the case is obviously a *typical* urgent ectopic gestation in a patient deeply shocked by hemorrhage, measures to combat shock must be instituted immediately. Delay in treating shock invites disaster. Morphine or pantopon, external heat and hypodermoclysis should be administered. Titus recommends a submammary infusion of 250 to 300 cc. of normal salt solution. The Trendelenburg position should be employed in all cases of shock and hemorrhage to improve the blood supply to the brain. Stimulants, cathartics or enemas should be avoided. Welton and Glass disapprove of cathartics or enemas for a patient suspected of having ectopic gestation.

Blood pressure and pulse readings should be taken frequently. It is advisable to take blood pressure recordings every fifteen to thirty minutes, because a change may occur abruptly. If the patient shows definite signs of anemia and if hypotension is very pronounced, oxygen should be administered. Abdominal distention may require treatment in patients with abdominal pregnancy.

If the case is one of *atypical* ectopic gestation,

the patient should be removed promptly to the hospital and kept absolutely quiet in bed. Preoperative treatment should be designed to prevent rupture; or if its occurrence is suspected, to prevent disturbance of the sealed-off blood. The slightest exertion may cause renewed hemorrhage.

Vaginal and abdominal examinations should be minimized and should be carried out with extreme care to preclude possible rupture or recurrent hemorrhage. Care is especially imperative if the examination is made under anesthesia.

Shock is usually not severe in these cases. The blood pressure may be unaffected or it may drop progressively.

Diet should be regulated to avoid diarrhea and to avoid the collection of gas with resultant pressure.

In this common type of case the surgeon may wish to establish a correct preoperative diagnosis by means of some of the procedures discussed in the section on "Diagnostic Aids."

Time of Operation. There is general agreement that prompt surgical interference should follow the diagnosis of early ectopic gestation. The time of operation in advanced abdominal pregnancy is discussed under the treatment of that subject.

In cases in which the clinical picture indicates an intact ectopic gestation, preparations should be made for immediate laparotomy. This applies especially to interstitial or isthmial pregnancies, ruptures of which pursue a violent course.

When the patient's condition is precarious and the diagnosis is in question, Titus advises laparotomy "with precisely as much assurance as though the diagnosis were an established fact." This principle is no different from that promulgated by Lawson Tait when he adopted the practice of immediate laparotomy to "make the diagnosis certain and a successful treatment possible" in all cases in which a correct preoperative diagnosis is impossible

but in which the symptoms do not point definitely to malignant pathologic conditions. In general we agree with Dannreuther that it is better to operate on ten patients and discover that the diagnosis was wrong than to make a single error of omission.

By prompt or immediate operation I do not mean surgical interference while the patient is in the throes of initial shock, as evidenced by low systolic blood pressure, rapid, thready pulse and symptoms of complete collapse, sequelae of massive hemorrhage or violent trauma, or both. However, usually an hour or more elapses between the height of the initial shock and the time required to complete preparations for an aseptic operation. During this interval the patient usually responds to preoperative treatment and the intensity of the shock is reduced, as shown by the improvement in the volume of ·pulse and systolic blood pressure. This rallying point is the time for operation. DeLee and Greenhill (1947) inform us they "are not afraid to operate while the patient is in shock but we give blood or plasma or both during and after the operation."

In 1924 Welton favored expectant treatment to raise the systolic blood pressure. However, he was opposed to waiting for a return to a normal blood pressure reading because the higher level might dislodge a clot and start further hemorrhage and shock. This author advocates immediate operation (1) if the systolic pressure shows some improvement and then remains stationary; (2) if it rises and then begins to fall; (3) if it continues to fall in a patient not in shock. In the last case hemorrhage is responsible for the dropping blood pressure. Welton believes that preoperative treatment to reduce shock should not extend beyond two hours.

To reduce mortality in this condition Wetherell advocates operation, plus transfusion, *as the blood pressure approaches normal.* Farell and Scheffey attributed the only fatality in their 1943 series to preoperative delay of several hours in the receiving ward. Ludwig considered one of his deaths the result of treatment to improve the preoperative condition although it was obvious the patient had lost a great quantity of blood. During expectant treatment she experienced a sudden additional hemorrhage and died.

Schumann believes it is unwise to wait too long for reaction from shock in a patient *in extremis* for she may die instead of rallying. He advocates immediate laparotomy for ruptured ectopic cases and adds: " . . . ruptured ectopic pregnancy is the one [condition] wherein even patients operated upon almost in *articulo mortis* recover with the most surprising rapidity."

As Fitzgerald and Brewer say, an exsanguinated patient is always a bad risk whether or not operation is performed, and it is my belief that such a woman should be given the benefit of prompt ligation of the bleeding points. When the patient is moribund the operation will add very little to the existing shock, the ultimate reduction of which depends upon control of the bleeding blood vessels.

Anesthesia. The choice of suitable anesthesia and its careful administration are paramount factors in the success of operations for ectopic pregnancy. The anesthetic time should not be too long, but it should provide adequate relaxation and take care of all contingencies, including the prolonged exploration sometimes required in abdominal gestation. The anesthesia should not obstruct the swift completion of the operation or contribute to shock or blood loss.

In selecting an anesthetic, the competency of the anesthetist should be considered. If the hospital does not employ the services of a specialist for this work, the simplest procedure compatible with efficient operative technic should be used.

Some authorities object to local and spinal anesthesia. Titus limits the use of local anesthesia, in combination with mild basal rectal anesthesia, to critically ill patients. He maintains that the unobstructed progress of the operation is interfered with by the nausea, vomiting and exertion which often occur as the peritoneum is incised under local anesthesia. The same objection applies in greater measure to spinal anesthesia, which possesses the additional disadvantage of being dangerous in pregnant women. Falls (1936) uses local anesthesia for most "tragic" cases and for vaginal-route ectopic operations because, in his judgment, it does not add to shock as does general anesthesia. I prefer to use cyclopropane anesthesia with which I have had marked success.

Transfusions. The blood volume can be restored to normal by whole blood, plasma, and solutions of salt and glucose. Successful operation on patients in shock depends more

upon the maintenance of blood volume than upon any other single factor. Before the abdomen is opened a needle is introduced into a vein and saline or saline and glucose are administered. This is done just fast enough to keep the vein patent; and as soon as the abdomen is open and the blood vessels are clamped, the fluid is allowed to run a little faster, the rate being increased according to the judgment of the surgeon. This procedure is to prevent the veins from collapsing and to prevent the loss of time in finding a suitable vein. Veins are sometimes so collapsed that after they have been cut down and exposed, they cannot admit fluid. If the patient's condition demands plasma or blood, these are in readiness to replace the glucose and saline during and following operation.

While the patient is receiving the saline and glucose or plasma, her blood should be typed and checked for the Rh factor and compatibility.

Plasma possesses certain advantages over whole blood in that it is available at once and is free from such reactions as may arise from the use of incompatible Rh blood.

Whole blood is the supportive measure *par excellence* in operation for ectopic gestation. The time for the transfusion will depend upon the clinical picture. In advanced abdominal pregnancy, for example, a transfusion should be given before the operation is started and should be repeated whenever needed. In cases of massive hemorrhage from a ruptured tube, many authorities advocate deferring transfusion until the operation is under way because of its action in raising the blood pressure, with possible danger of further hemorrhage from the transfused blood.

The pulse rate and blood pressure will indicate the quantity of blood needed and until these indices are satisfactory, repeated transfusions should be given. Too much emphasis cannot be placed upon adequate transfusion. Some of my patients received as much as 1,500 cc. of blood.

In our series fifty-two patients (30.1 per cent) received intravenous infusions of glucose and saline; forty-two (24.2 per cent) received glucose and saline with blood transfusion; thirteen (7.5 per cent) were given glucose and saline, plasma and blood; eleven patients (6.4 per cent) were given blood transfusions; five (2.9 per cent) received glucose and saline

with plasma; three (1.7 per cent) received plasma, and one patient (0.6 per cent) was given plasma and blood. In forty-six cases (26.6 per cent) no transfusion or intravenous infusion was given either during or after the operation.

Calkins refers to two fatal cases in one year; each patient had received only one transfusion. It is his belief that "two or three transfusions would have produced a different result." Sadler reports an average of 1,400 cc. of transfused blood for patients in shock and an average of 900 cc. for those not in shock.

In a case of extremely profuse hemorrhage, massive transfusions of 1,000 to 1,500 cc. may be administered by the simultaneous employment of two or three donors.

Autohemoclysis may be employed if necessary by straining the free intraperitoneal blood through gauze and injecting it intravenously. To every 100 cc. of blood 5 cc. of 5 per cent sodium citrate should be added. In the absence of fresh blood and plasma, autohemoclysis may be life-saving. However, because this blood lacks fibrin so necessary in hemorrhage and because it may cause sepsis, it should be used only under exceptional circumstances.

Solutions: Glucose and Saline. If neither fresh blood nor plasma is available, hypodermoclysis or intravenous infusion of saline should be used. For preoperative treatment of shock these measures are preferred to blood. However, when blood transfusion is indicated, these procedures are definitely secondary choices. There is no doubt that modern facilities for replacing lost blood have played a major role in the improvement noted in recent years in the mortality rate in cases of ectopic pregnancy.

Management of Free Blood and Blood Clots. Authorities differ on the removal of free blood and blood clots although there is universal agreement on the desirability of sufficient removal to permit a clear view of the operative field. Some surgeons recommend removal of free blood and blood clots to prevent trauma, adhesions and infection. Fresh blood is a peritoneal irritant. Woodhouse believes that removal of blood clots facilitates convalescence. Other surgeons recommend leaving the blood in the peritoneal cavity to save time, to reduce trauma and to give the patient the benefit of the reabsorbed blood. According to Litzenberg (1937) blood in the peritoneal cavity

does not cause adhesions but trauma from sopping or scooping it out may. This author saw the hemoglobin index go up 35 per cent in forty-eight hours when a large quantity of blood was left in the peritoneal cavity.

While I prefer to remove blood clots, I believe the experience of the individual surgeon and the exigencies of the particular operation are undoubtedly the best guides.

Postoperative treatment depends upon the character of the operation. If there has been massive hemorrhage, treatment must be instituted to check shock, acute anemia and complications caused by the first two conditions. Shock responds to external heat and to the Trendelenburg position, which permits retention of blood in the major vessels of the head and trunk. Oxygen should be used if indicated. Anemia is best treated by transfusion and later by iron.

Fluids are always important postoperative therapy and may be administered orally, subcutaneously and intravenously. In giving intravenous infusions of saline and glucose solution, one should bear in mind that the vascular system cannot accommodate excessive amounts of fluids without cardiac embarrassment. As fluid is absorbed rapidly, it may be supplemented by saline solution per rectum. Morphine may be used freely for pain and restlessness, especially during the first twenty-four hours. Energetic catharsis should be avoided and low enemas given.

As I stated in the paragraph on transfusion, this procedure is the outstanding supportive measure in the treatment of ectopic gestation. It is virtually a *sine qua non* in the operations for abdominal and cervical pregnancy as well as in other ectopic gestations involving massive hemorrhage. The blood pressure and the volume of pulse dictate the need for transfusion, which should be continued postoperatively until the patient's condition is satisfactory. Postoperative distention may require treatment by the usual methods.

Treatment of Tubal Pregnancy. The treatment of this condition covers three distinct clinical groups: (1) typical cases of tubal rupture with massive intraperitoneal hemorrhage; (2) atypical cases of unruptured sac, minute rupture, tubal abortion or tubal mole; (3) atypical cases of pelvic hematocele.

The expedition of the operative procedure is governed by the severity of the symptoms, which in turn depends upon the site of the ovum—the closer to the uterine cornua the more critical the clinical picture. For example, the rupture of an interstitial gestation is especially fulminant and necessitates immediate laparotomy.

Group 1. Treatment of Tubal Rupture with Massive Intraperitoneal Hemorrhage. The patient in serious condition from hemorrhage and shock should receive surgical treatment as rapidly as is compatible with efficient work and minimal trauma. Any alternative course will terminate fatally.

The skin of the abdomen is disinfected. The patient is placed in a moderate Trendelenburg position and anesthesia is induced. Welton and Glass believe patients experience a more favorable postoperative course when an extreme Trendelenburg position is not used. A midline abdominal incision is made, sufficiently large to permit ready access to the pelvic organs. The purplish coloration of the peritoneum caused by intra-abdominal hemorrhage confirms the diagnosis. If there is a great quantity of free blood in the abdominal cavity, the pressure is increased; and when the peritoneum is incised, blood spurts forth. As the peritoneal opening is lengthened, the blood gushes out. If it is possible to reach the affected side of the uterus without first introducing laparotomy pads, this should be done; but if the uterus cannot be reached because of the intestines, one or more pads should be introduced quickly into the abdominal cavity in order to wall off the intestines and facilitate the grasping of the lesion.

The uterus is grasped in one hand and two clamps are applied. The upper clamp is placed on the proximal end of the fallopian tube and the lower one on the mesosalpinx. These two clamps should converge, like the sides of the letter V and should be placed deeply enough to compress the bleeding vessels. The upper clamp facilitates raising the uterus and adnexa closer to the abdominal wound. The affected tube is then excised and the clamps replaced by suture ligatures of chromic catgut. If the ovary is also to be removed, the upper clamp is applied more deeply so as to include the ligamentum ovarii proprium. The lower clamp is applied to the infundibulo-pelvic ligament, and is directed toward the upper clamp, again forming a V-shaped figure. The fallopian tube and ovary are then excised and the clamps

replaced by suture ligatures. If the ovary is not to be removed, the upper clamp is applied somewhat superficially so that it will not interfere with the ovarian blood supply. The raw surfaces are peritonealized.

Many surgeons remove the blood clot and free blood; others do not interfere with the blood or clots. I remove the larger blood clots and leave the free blood in the abdominal cavity.

The probability of a normal intra-uterine pregnancy through a tube damaged by an ectopic pregnancy is very remote; the chances of a recurrent gestation in such a tube are great because the same etiologic factors responsible for the first aberrant nidation may cause a second one. Therefore, the tube *in toto*—including its interstitial portion—should be excised.

Danforth states that complete removal of the tube does not lengthen the operation and spares the woman the risk of later trouble. However, if the woman is childless and the other tube has been removed, for one or another reason, at a previous operation, as much as possible of the proximal portion should be saved. If the condition of the patient permits, a plastic operation should be done on this retained tubal portion, in order to keep the distal opening patent. Some of my patients did conceive after such a procedure.

For example, Mrs. R. M., at the age of fourteen was operated on for what was reported to be a "cyst of womb." When she was thirty-five years of age, I performed a right salpingo-oophorectomy for a right ruptured tubal pregnancy. I left a small part of the proximal portion of this right tube and created a new, patent ostium abdominale. Routine examination of the left adnexa revealed a normal ovary and the absence of the left tube, apparently the result of the operation for "cyst of womb," which was in all probability a large hydrosalpinx. Two years later, this woman conceived and I delivered her at term by cesarean section. A normal, living child was obtained. This is also an example of migration of ovum to the opposite side.

According to Mayo and Strassmann, the likelihood of normal intra-uterine gestation following one ectopic pregnancy is approximately ten times greater than the likelihood of a recurrent ectopic pregnancy. For this reason the other tube should not be removed

unless it presents gross evidence of disease and is obviously permanently functionless. Occasionally the opposite tube may also harbor an ectopic gestation or, as in 5 per cent of Kerr's cases, a hematosalpinx. In my series there was one case which I considered a bilateral tubal pregnancy.

Before the peritoneum is completely closed, warm normal saline solution is often introduced into the abdominal cavity if the patient is in great need of fluids. I have had very satisfactory results with this procedure. The abdomen should be closed without drainage; drainage increases the danger of infection in the presence of excellent cultural material and may give rise to postoperative adhesions.

Vaginal Section. Some surgeons believe that anesthesia, abdominal exposure and trauma add to shock in typical cases of extreme severity. For this reason they perform vaginal section on such patients. The position of the uterus determines whether a posterior or an anterior colpotomy is to be done. Babcock, who has had excellent results with this method over a long period, employs the following technic:

A tenaculum forceps is used to pull the cervix downward and forward. The cul-de-sac is incised with a curved scissors, two fingers are passed through and the opening enlarged by traction. The tube is located by the fingers and brought down into the vagina. If adhesions interfere, a ring forceps may be inserted, the tube grasped and drawn down as the adhesions are pushed away. If the patient is pulseless the tube is clamped near the enlargement, a gauze drain is inserted in the cul-de-sac and the patient returned to bed. The abdominal cavity is cleared of blood spontaneously without sponging or irrigation. Usually the patient is not in such desperate condition that time cannot be taken to ligate the tube and excise the lesion.

Falls (1936), who also prefers this operation for desperate cases, performs it under local anesthesia.

Vaginal section has the advantage of saving time when time is of paramount importance. In Allen's experience it greatly reduced the length of hospitalization, maternal risk and postoperative discomfort. However, the surgeon should be prepared to find pelvic infection as well as an ectopic gestation.

I prefer the abdominal route and agree with

Stander that vaginal section for a recently ruptured tubal gestation restricts the view of the operative field; there is always a possibility that the operation cannot be completed by the vaginal route.

In cases of *interstitial pregnancy* which have progressed beyond five months, the fundus of the uterus is so badly torn by the rupture that supravaginal hysterectomy is the wisest procedure. (Figs. 9, 10, 11, 12 and 13, Case III.) In earlier interstitial gestations, in which the sac has grown out from the uterus instead of into the uterine wall, cornual resection with conservation of the uterus may be performed. However, the cornua are vulnerable and the possibility of recurrent ectopic gestation must not be overlooked in deciding upon the extent of the operative procedure.

Group 2. Cases of Unruptured Sac, Minute Rupture, Tubal Abortion and Tubal Mole. This group constitutes the type of ectopic gestation most frequently encountered. The prodromal picture is often anomalous and perplexing. As operation is imperative, expectant treatment should not be too long. The sac may rupture without premonition or the blood clot may be disturbed, with resultant massive hemorrhage. Hence, surgical interference should be undertaken as promptly as possible. The procedure is relatively simple. The tube and its neighboring parts may be separated by minor adhesions which are easily freed. The sac is then removed in the manner described for *Group 1* cases. The tube should be excised completely just as in typical cases.

If a hematoma is found as the result of rupture into the broad ligament, the broad ligament may be split open, the blood clot removed and a gauze packing inserted into the cavity. The broad ligament is then sutured and the end of the gauze drawn through the vagina. When drainage is indicated, I prefer vaginal to abdominal drainage.

Kerr refers to conservative treatment of the tubes in tubal gestation; and although he has tried it, he does not speak of this method with enthusiasm. He describes two procedures: (1) dilatation of the abdominal end of the tube and expression of the ovum; and (2) splitting the tube and shelling out the ovum. In the second procedure the wound in the tubal wall is sutured. Kerr says that the frequent persistence of oozing blood makes one afraid to leave the tube behind. He reminds us that, while a distended tube will eventually return to normal, it lacks the contractility and retractility of the uterus. Hence a tube which has once been the seat of an ectopic gestation is prone to harbor another.

Cornual Pregnancy. The pregnant cornu is resected by the removal of a V-shaped block of tissue. The bleeding is likely to be very profuse. The blood vessels are ligated carefully and the uterine wound is closed with several layers of sutures, as in myomectomies. A figure-of-eight suture closes the wound effectively.

One woman on whom I operated for cornual pregnancy was delivered of a living, full-time child four years later.

Group 3. Pelvic Hematocele. This condition is an accumulation of blood in the cul-de-sac, caused by abortion or rupture of a pregnant tube. In ectopic gestation one should not await the formation of hematocele to make a diagnosis of tubal pregnancy. Kerr reminds us that pelvic hematocele is an indication that the physician failed to make an early diagnosis of tubal pregnancy or that the patient did not seek medical counsel until the pelvic mass had formed. When the blood coagulates it forms a mass, firm in some areas, soft in others. The collection of blood should be treated operatively by laparotomy or by incision and drainage through the vagina.

Small pelvic hematoceles may sometimes be absorbed. If one chooses to treat the condition expectantly the patient should remain in bed in the hospital. The length of time required for complete absorption varies and depends chiefly on the size of the pelvic mass.

Large hematoceles are slow to disappear. In the process of absorption they may either rupture, producing hemorrhage, which necessitates laparotomy; or they may suppurate. Either course involves protracted convalescence and eventuates in lasting pelvic injury and sterility, especially if the gestation was well advanced. Large hematoceles should be treated not expectantly but surgically.

Disadvantages of the absorption treatment of pelvic hematocele are (1) protracted convalescence; (2) continuous or spasmodic uterine bleeding; (3) pain, which is sometimes very severe; (4) the great hazard of sepsis and pelvic abscess (Nixon).

Either laparotomy or colpotomy may be elected for the surgical treatment of a pelvic

hematocele. Most operators prefer the abdominal route because, as DeLee and Greenhill (1943) say, it gives better control of all eventualities. This avenue permits the removal of all blood clots and the correction of any pathologic condition of the uterus or its adnexae (Kerr). In Brown's series posterior colpotomy was restricted to two cases of large hematocele, with unsatisfactory results. Convalescence was lengthy and febrile. Hospitalization for these patients was longer than for any ectopic case operated upon by the abdominal route.

The patient's general condition including elevated temperature and pulse rate will point to a septic state. On bimanual examination the cul-de-sac may be found to be bulging and at times fluctuation may be elicited. In such cases it is advisable to aspirate in order to determine whether or not there is blood or pus in the cul-de-sac. If blood is present, laparotomy is preferable; if pus is found, it is best to do a colpotomy either with a Ludwig Fraenkel trocar and insertion of a Fraenkel silver drain, or a transverse incision may be made in the cul-de-sac close to the cervix toward the rectum and a rubber drainage tube introduced. I prefer the longitudinal incision because I believe there is less likelihood of injuring the ureters if these are displaced. Many surgeons prefer the transverse incision in order to avoid injury to the rectum.

Treatment of Abdominal Pregnancy. Most abdominal pregnancies are secondary implantations and are usually the result of an early tubal abortion or rupture. If the woman seeks medical advice when she experiences symptoms which lead to secondary nidation in the abdominal cavity, the gestation should be terminated by prompt laparotomy. However, many women do not present themselves for examination until the fetus is viable or on the verge of viability. In the absence of complications which would make an immediate laparotomy imperative the question arises: Should operation be deferred in order to obtain a living child? The ramifications of the situation should be explained to the patient fully. If she insists upon delay, she should consent to constant observation for hemorrhagic and septic emergencies and to conditions which would make the performance of immediate laparotomy possible should the necessity arise. In such cases I prefer to keep the patient in the hospital until the decision to operate is made, regardless of the time required.

If deferment is elected, it is the judgment of several authorities that the thirty-sixth week is the best time to operate. According to Gardner and Middlebrook, maternal risk in the presence of complications, such as hypertension, albuminuria and cardiac conditions increases during and after the eighth month. The incidence of rupture of the sac, placental detachment with attendant massive hemorrhage and fetal death is much higher after the thirty-sixth week. In intra-abdominal gestation, sepsis is a constant source of danger because a developing placenta, if attached to the intestines, invites erosion or penetration by the chorionic villi, with resultant perforation of the bowel.

Some surgeons recommend prompt laparotomy after the diagnosis is established. Many fetuses succumb early; others are deformed as a result of development in an unnatural environment. Deformities are caused by abnormal position and by pressure resulting from reduction in the quantity of amniotic fluid. Some defects can be corrected by operation as in my own case. (Figs. 36 to 44, Case IX.) In the series of 316 abdominal gestations discussed by Hellman and Simon, only 50 per cent of the infants survived eight days or longer.

If the question of a living child does not enter into the case and the time of operation is left to the judgment of the surgeon, he will have to decide (1) whether to wait until the fetus dies, or (2) if the fetus is dead, whether to wait until the maternal sinuses become sufficiently thrombotic to preclude dangerous hemorrhage. It is, of course, much simpler to detach a placenta after its blood supply has been abolished.

According to Gardner and Middlebrook, the placenta of ectopic gestation bears a greater resemblance to placenta accreta than to the normal intra-uterine placenta.

Tait says that "when the placenta has acquired adhesions outside the uterus it is in a condition altogether different from that in which it is placed when in contact with the endometrium."

Usually delay is safe because the sac is isolated by intestinal adhesions (Kerr). Litzenberg (1947) sees little risk in waiting for the placental blood supply to become obliterated.

Stander suggests that operation be deferred six or eight weeks in order to obtain obliteration of the placental blood supply; he directs attention to the value of the Aschheim-Zondek test in determining chorionic death.

In spite of the fact that some authorities prefer to wait until the placental blood vessels are obliterated, others favor prompt operation as soon as the diagnosis is established.

DeLee and Greenhill (1943) recommend that only skilled abdominal surgeons perform this operation because of the risk of complications such as hemorrhage and possible ureteral and intestinal injury. They also offer the further good advice that before the surgeon starts the operation he should be sure he can finish it. Because of the low incidence of abdominal gestation, an operation of this kind is a rarity in the experience of most general surgeons. The different anatomic arrangements presented by sac and placental locations make each case a unique surgical experience in the life of the busiest obstetrician and gynecologist.

Treatment consists of removal of the fetus and disposition of the sac and placenta. The placenta is either removed or left *in situ*, with or without drainage.

The surgeon rarely encounters difficulty in opening the sac and removing the fetus, but management of the sac, the adhesions, and more especially of the placenta, and control of hemorrhage present surgical problems of the first magnitude. The ideal procedure, of course, is to remove the sac *in toto:* fetus, membranes and placenta. According to Mason, the death rate is lowest in cases in which complete placental removal is undertaken and in which drainage and marsupialization are not used. (Cases IV, VI, VII, VIII and IX.)

Surgical Technic. With the patient in a moderate Trendelenburg position, the abdomen is disinfected and opened by a paramedian incision from the pubis to the umbilicus. An immediate attempt to locate the placenta is made. Sometimes it is necessary to open the sac and extract the fetus and then separate and remove the sac and placenta. The placenta may be situated on the pelvic structures or on the abdominal contents (intestines, liver, mesentery, etc.). If it can be readily removed *in toto* without injury to vital organs and if the placental blood supply can be controlled by ligation, this should be done. The incision should be closed without drainage. In complete

removal of the placenta it is imperative that all circulation to the placental site be ligated.

The surgeon should be prepared to deal with profuse bleeding because as soon as he begins to strip off the placenta he may encounter violent hemorrhage which cannot be controlled by clamps, stitches or packing. If the placenta is adherent to the intestines, liver or spleen, separation is likely to produce uncontrollable bleeding; the placenta should be left *in situ* and the abdomen closed without drainage. However, if in the judgment of the surgeon some portion of the placenta can be removed without causing excess bleeding, this should be done. If left *in situ*, the placenta will undergo the following types of change (in order of frequency): absorption, liquefaction, formation of a fluctuant tumor or suppuration. If a tumor forms or the organ suppurates, the sac may be readily incised and drained. This corresponds with the experience of other authors, including DeLee and Greenhill (1943).

According to DeLee and Greenhill (1943) in cases of intraligamentous or tubal gestation with few adhesions, "it may be possible to pedunculate . . . *after tying the ovarian vessels at the brim and clamping the broad ligament at the uterus.*" The placenta and sac are removed; the blood vessels, clamped and tied. "The bleeding areas are dried by suture, cautery, packing or sewing the peritoneum over them or a piece of omentum or fat from the belly wall may be sewed down over an obstinately oozing surface." DeLee and Greenhill (1943) compare the detachment of a placenta whose blood supply has been obliterated to the removal of an adherent ovarian cyst. However, even in this condition stripping off the organ may involve hemorrhage, and these authors advise removal of the tube or ovary or broad ligament—seldom the uterus.

Opinion is divided on the use of marsupialization when the placenta cannot be removed. Reel and Lewis resorted to this technic almost exclusively. They believe that drainage is a safeguard. Renner advises leaving the placenta undisturbed and performing a marsupialization operation "if hemorrhage or sepsis or both are feared." On the other hand, Mason regards marsupialization as highly undesirable. Sepsis is the great danger in the process. DeLee and Greenhill (1943), who do not recommend marsupialization, suggest packing the sac in the presence of hemorrhage or fetal infection.

They advise a light packing for sepsis and a firmer one for hemorrhage. The packing should be sewed to the edges of the abdominal incision. These authors say this treatment is not so effective for controlling hemorrhage because of the lack of counterpressure, but they regard it as important in sepsis in spite of the lengthy convalescence involved, which continues until complete placental absorption takes place. In one of my cases marsupialization was employed with good result.

Kerr advocates vaginal treatment of an infected sac which cannot be removed. If incision and drainage are impossible through this route, an opening should be made at a place which permits optimal drainage and which involves minimal danger of escape of the septic contents into the abdominal cavity. Detachment of an infected sac may result in serious complications.

According to Titus if partial placental detachment has occurred, it may be necessary to remove the organ. He recommends that a minimum of 5 Gm. of sulfathiazole powder be sprinkled into the cavity before closing or that the gauze pad be saturated with the same drug by soaking in a solution of its sodium salt before it is inserted as a pack. While the gauze pack controls oozing, its use should be avoided if possible because it is conducive to infection.

In operation for abdominal pregnancy, it is advisable to prepare sufficient blood for transfusion, which is frequently indicated. The surgeon should have adequate support in the way of assistants, instruments, gauze and a sterile aortic compressor. The latter one may be needed to keep the field bloodless while more permanent hemostatic measures are being carried out.

Ovarian Pregnancy. The treatment for ovarian pregnancy is ovariotomy as soon as diagnosis is made or suspected. Delay should be avoided because rupture is usually followed by massive hemorrhage. Greenhill advises marsupialization in the presence of furious hemorrhage. The tube is sometimes excised also. Kerr mentions conservative treatment for this condition; the ovum is excised and the ovary left in place.

Cervical Pregnancy. Since cervical pregnancy is not encountered frequently, the following operative technic is that employed by Studdiford (1945). (Fig. 14.) Before the fourth or fifth month surgical intervention is

usually necessitated by massive hemorrhage, rupture of the amniotic sac or perforation of the wall of the cervix. The placenta is firmly adherent and its detachment, which is piecemeal and incomplete, results in massive hemorrhage, difficult to stop with tampons. Large, repeated transfusions are imperative.

The products of most cervical gestations can be removed *per vaginam* with reasonable safety. If the pregnancy has advanced beyond the fourth month, total hysterectomy may be the safer procedure. Supravaginal rupture of the cervix should be treated immediately by radical surgical interference. Treatment of intravaginal rupture of the cervix is governed by the extent of hemorrhage. If this is profuse, cervical amputation or total hysterectomy may be necessary.

If the cervical wall has not been perforated (Fig. 14), conservative treatment may be successful. Manual or instrumental removal of the placenta may be accomplished completely or in piecemeal fashion. Packing will usually control the hemorrhage. Free use of blood transfusion will reduce the necessity for radical operation in this condition.

CONCOMITANT OPERATIONS

It cannot be too strongly emphasized that in order to control hemorrhage, reduce shock and trauma and prevent sepsis operation should be limited to the minimum procedure essential for treatment of ectopic gestation, i.e., ligation of the bleeding points and removal of involved pathologic structures (tube, ovary, etc.).

Occasionally additional surgical interference is required as in the cases of interstitial gestation or some isthmial implantations close to the uterine end which necessitate hysterectomy. (Figs. 9 to 13, Case III.) Occasionally a dangerous appendectomy may be imperative when the gestation involves the appendix. (Case VII.) Appendectomy should be avoided if possible since a potentially septic abdominal operation is especially hazardous in the presence of an excellent culture medium. Yet this elective operation is frequently reported. There may be some justification for correcting other pathologic conditions if ectopic gestation is not urgent and the danger of hemorrhage or sepsis is relatively remote.

Notwithstanding the desirability of minimizing surgical interference in these cases, an

amazingly high number of patients in some series had other pathologic conditions corrected, with the following results: (1) morbidity unaffected; (2) morbidity increased; (3) mortality increased.

TABLE X

CONCOMITANT OPERATIONS	No. of Cases
Appendectomy (appendix was involved)	5
Subtotal hysterectomy	6
Total hysterectomy	1
Salpingectomy	5
Oophorectomy	3
Myomectomy	3
Salpingo-oophorectomy	2
Oophorectomy and appendectomy	1
Salpingectomy, suspension and peritonealization of the small intestine	1
Salpingectomy and Baldy-Webster suspension	1
Resection of part of the ovary	2
Resection of the tube	1
Resection of the cornu	2
Dilatation and curettage; suspension of the uterus	1
Repair of incisional hernia	1

In this series of 173 cases of ectopic pregnancy various concomitant operations are reported in thirty-five patients (20.23 per cent). In the entire series seventeen cases are cited in which complications occurred, four of these occurring in the thirty-five patients who were subjected to elective surgical procedures.

The concomitant operations performed in our series are as shown in Table x.

Eighty-two of Leff and Winson's patients received elective surgical intervention with no more morbidity than that experienced by the group on whom only the essential operation was performed. Additional surgical procedures were carried out on twenty-eight of Schauffler and Wynia's sixty-five patients. There were no deaths and no increased hospitalization for this group. These surgeons believe that sterilization and correction of pelvic pathologic entities may contribute to the prevention of a recurrent ectopic.

Sixty-nine of Nucci's 150 cases had other pathologic conditions corrected. Although this group showed no increased morbidity and the average hospitalization was 15.8 days against 19.6 days for the series as a whole, in two of the four fatal cases elective operations had been performed. In the series of fatalities studied by Williams and Corbit elective surgical procedures were performed in eighteen of the sixty-five operative patients. Weil believes

that additional operation was a contributing factor in two of his fatalities. Hysterectomy had been performed on five of the eight patients who died in the series reported by Graffangnino et al.

TABLE XI

Postoperative Complications	No. Cases
Abdominal distention	2
Abdominal wound infection	2
Cul-de-sac abscess	2
High postoperative temperature (patient treated with penicillin)	1
Paralytic ileus	2
Pelvic exudate	2
Peritonitis	1
Pneumonia	3
Thrombophlebitis of left lower extremity	2

Other surgeons report the following elective operations: amputation of cervix; appendectomy; bartholinectomy; bilateral oophorectomy; bilateral salpingectomy; cauterization of cervix; fundusectomy; herniorrhaphy; hysterectomy; myomectomy; oophorectomy; plastic operation; removal of parovarian cyst; repair of cystocele and rectocele; suspension of uterus; umbilical herniorrhaphy; vaginal plastic operations.

In this series seventeen patients (9.8 per cent) developed the postoperative complications shown in Table xi.

MORTALITY

In this series of 173 cases there were five deaths, a mortality rate of 2.9 per cent. This figure is in line with the mortality statistics of recent years. Death resulted from paralytic ileus, hepatorenal syndrome, peritonitis (infected ectopic gestation) and in two instances hemorrhage.

In twenty series which include tubal, ovarian and abdominal gestations, reported between 1938 and 1947, there was a total of 2,634 cases, with sixty-three deaths, a mortality rate of 2.4 per cent (Farell and Scheffey, Johns, Langman and Goldblatt, Lee, Leff and Winson, Lisa et al., MacFarlane and Sparling, Marchetti et al., H. E. Miller, Nucci, Rogers, Sadler, Schauffler and Wynia, Shaw, Siegler, Torpin (1944), Ware and Winn—two series, Weil, and Woodhouse). This average rate agrees with that of 2.4 per cent reported by Litzenberg in 1947. His figure is based on 1,421 cases from six teaching clinics.

In the City of New York in the years 1934

to 1946, inclusive, there were 4,328 maternal deaths, 274 of which were caused by ectopic gestation. Thus, this condition was responsible for 6.3 per cent of maternal deaths in the period stated. Newberger reports the occurrence of 398 cases of ectopic gestation with seventeen deaths in Illinois during 1944. This represents a mortality rate of 4.27 per cent.

Some authors report no fatalities: Lee, fifty-eight cases; Leff and Winson, 212 cases; Rogers, sixty-five cases. Others report no deaths in the last years of their series: Langman and Goldblatt, no deaths in their last three years; Schauffler and Wynia, none in their last eight years; Siegler, none from 1936 through 1944. The physical condition and youth of ectopic patients contribute to the relatively low mortality in this condition.

It seems fitting at this point to refer to the successful operations performed by Lawson Tait. In 1883 he operated for ruptured ectopic gestation and "wasted much time in trying to stop" the hemorrhage, with the result that the patient succumbed. He then concluded "that the true method of operating in such a case was to separate adhesions rapidly, regardless of bleeding and make at once for the source of the haemorrhage, the broad ligament, tie it at its base, and then remove the ovum debris. . . . This I have done now in thirty-nine cases with one death." The one death to which Tait referred occurred in a woman who was virtually in *articulo mortis* when he first saw her. Tait's mortality rate for the thirty-nine patients was 2.56 per cent. If we include the fatality in which he "wasted much time," the mortality rate goes up to 5 per cent. When we consider that he had to operate without many of the supportive measures available today—blood transfusion, sulfonamides, penicillin, streptomycin, modern anesthesia and modern aseptic aids—the low mortality rate of this pioneering gynecologist stands out as a tribute to his surgical genius which will long remain a lodestar for gynecologists everywhere.

Evaluation of the mortality rate in any series should take into consideration conditions peculiar to the practice of the operator. A surgeon whose patients, for the most part, are women of high mental endowment and economic status will lose fewer cases of ectopic pregnancy than will the one who treats chiefly poor women, many of whom are clinic patients. Women of financial means, whether they are

intelligent or not, usually consult a physician at any departure from good health. But poor women, intelligent and otherwise, are frequently "too busy" or lack the means with which to seek medical aid at the onset of symptoms. The result is that many of them carry on their daily routine while experiencing continuous and slow hemorrhage which eventually exsanguinates them. Or, ignoring the early signs of their condition, they go along until a sudden, massive and sometimes fatal hemorrhage overtakes them.

The type of hospital also influences the mortality rate. In reporting their series of 500 cases Fitzgerald and Brewer attributed their high mortality (thirty-nine deaths, 7.8 per cent) in part to two factors: (1) Cook County Hospital is an emergency hospital and many patients are virtually hopeless cases upon admission; (2) only relatives are permitted to provide transfusions and many proved reluctant to act as donors. Hospitals which serve a wide rural area are apt to receive more delayed, and consequently advanced, cases than institutions whose patients come from within a narrow radius.

Litzenberg (1947) found that the principal cause of death was neglect before hospitalization. Gordon (1936) considers failure of diagnosis the most important factor in mortality. His study (1944) of maternal deaths from hemorrhage in Brooklyn in 1943 included nine cases of ectopic gestation. Regarding six of these deaths he says, "The optimum time for operation passed . . . due to long delay in diagnosis."

Williams and Corbit, who made a study of 101 fatal cases of ectopic pregnancy in Philadelphia, found that a prime cause of death lay in the fact "that the true state of the condition . . . and its acute emergency nature were largely overlooked by the family physician who first saw these cases." Of the sixty-five patients operated upon in their study twenty-one were considered good surgical risks. Hemorrhage and shock caused sixty-eight deaths; infection, nineteen. The hospital chief was considered responsible for forty-five deaths, fifteen of which resulted from sepsis. Elective operation was performed in eighteen cases. Avoidable error in technic caused ten deaths from infection or secondary hemorrhage.

The study made by Williams and Corbit confirms the reports of many other investiga-.

tors that hemorrhage, shock and sepsis are the leading causes of death in ectopic gestation. These conditions result from failure of diagnosis; from failure to operate; delay in operation; inadequate operative procedure; poor operative technic; concomitant operations; absent or insufficient transfusion; failure to treat shock postoperatively, especially with transfusion. Correct early diagnosis, immediate preoperative treatment of shock, careful choice of anesthetics, prompt operation, adequate blood transfusions, sulfonamide drugs, penicillin and streptomycin if needed and suitable postoperative treatment including necessary transfusion can combine to prevent mortality in this condition.

Educating women to report promptly any menstrual aberration should reduce mortality in ectopic gestation. Women should be taught that it is of great importance to keep a written record of their menstruation and to teach their daughters when they reach puberty to do likewise. Yet in only eighteen of the cases studied by Williams and Corbit was the patient considered solely responsible. Because of the relatively high incidence of this serious disease, it is the duty of the general practitioner to familiarize himself with all the ramifications of the condition. He, like the gynecologist, obstetrician and general surgeon, should be "ectopic-conscious."

Abdominal Pregnancy. The death rate in abdominal pregnancy is much higher than the general rate for ectopic gestation. In this series it was 11.1 per cent, representing nine abdominal pregnancies with one death. There were sixteen deaths (23.2 per cent) in the sixty-nine cases reported by Beacham and Beacham, Colvin and McCord, Cornell and Lash (1934), Mason, Reel and Lewis and Swanson. The 101 fatal cases of ectopic pregnancy studied by Williams and Corbit included five deaths from secondary abdominal pregnancy. In 1933 Cornell and Lash reviewed 226 cases from the literature; there were thirty-one deaths, a mortality rate of 13.7 per cent. In Mason's 1940 review of sixty-nine cases—sixty-six from the literature and three of his own—there were thirteen fatalities, a mortality rate of 18.8 per cent. It is significant that in Beacham and Beacham's series of twenty cases, covering the eight-year period from July 1, 1937 to June 30, 1945, there was only one death. As a contrast to this low

mortality rate there were four deaths in Swanson's series of ten cases, representing all fatal abdominal pregnancies reported in Detroit in 1933. Without doubt the more widespread use of whole blood and plasma and the introduction of antibiotic drugs in recent years have been important factors in treating shock, hemorrhage and sepsis—the three ranking causes of maternal death in this condition. Yet, even with the aid of modern scientific advances, a mortality rate of 5 per cent in this serious condition is a noteworthy achievement, especially in patients treated in a large public hospital.

The principal cause of maternal death is shock due to violent hemorrhage resulting from the attempt to remove a firmly adherent non-thrombotic placenta. Sepsis is also well represented as a cause of death. The cause of death in the writer's case of abdominal pregnancy was hepatorenal syndrome. Death occurred on the ninth postoperative day.

The fatalities reported by Beacham and Beacham and by Swanson were traceable to incorrect diagnosis, thus emphasizing the importance of diagnostic perspicacity in a condition so often presenting a perplexing symptom-complex. In Cornell and Lash's 1933 study only 35 per cent of the cases were diagnosed before operation. Reel and Lewis attributed one of their deaths to failure to give the patient a transfusion before operation; a suitable donor could not be obtained in time. In only two of Colvin and McCord's fatal cases was operation performed; both patients died of general peritonitis.

Reduction of mortality in abdominal pregnancy largely depends upon early diagnosis, judicious management of the placenta and free use of blood transfusion.

ANALYSIS OF DEATHS

CASE I. D. B., a negress aged thirty-three, was admitted to the hospital on December 15, 1941, with the complaint of left lower quadrant pain and vaginal bleeding. The menses had always been normal except for occasional clots. The last normal menstruation occurred on September 10, 1941. The next menstruation was expected to occur about October 8th but did not appear until October 12th. On this date spotting began and continued until October 24th. The patient bled profusely from December 5th to December 10th when the hemorrhage was arrested by packing. However,

there was a yellowish discharge which continued until she was admitted to the hospital on December 15th.

Two months prior to admission the patient had antiluetic treatment. She was gravida IV, para III. She had one normal living child. One seven months' fetus had died at the age of three days and one stillbirth had occurred fifteen years prior to admission.

Abdominal examination revealed marked rigidity, direct and rebound tenderness on the left side, most noticeable in the left lower quadrant. There were moderate rigidity and rebound tenderness in the right lower quadrant. There were no masses palpable through the rigid abdominal wall.

Pelvic examination of the external genitalia proved to be negative. The introitus was parous. The cervix, which was elongated and soft, was directed downward and forward. Because of abdominal rigidity, the upper limit of the ante-flexed uterus could not be mapped out. There was a very tender right-sided mass on the posterior plane reaching 5 cm. above the level of the pubis. On the left side, 4 cm. above the level of the umbilicus, there was an elastic, tender mass which bulged slightly into the left lateral fornix. Rectal examination revealed the same findings in more pronounced degree.

The laboratory findings revealed that the hemoglobin was 80 per cent; red blood cells 6,500,000; white blood cells 14,400; band neutrophils 12 per cent; segmented neutrophils 60 per cent; lymphocytes 20 per cent; monocytes 8 per cent. Sedimentation rate 33 mm. Serologic and Aschheim-Zondek tests were negative. Temperature was 101.6°F.; pulse 100; blood pressure 96/60; respirations 20.

Preoperative diagnosis was tubo-ovarian abscesses; infected ectopic pregnancy.

At operation on January 12, 1942, laparotomy revealed fresh blood, an abscess surrounding the sigmoid and a hematocele of the right adnexa, with a fetus measuring 7.5 cm. crown-rump. The left adnexa was fixed by adhesions and formed a tubo-ovarian abscess about 8 cm. in diameter. A right salpingo-oophorectomy was performed but because of the poor condition of the patient the left adnexa was not removed. A Penrose drain was inserted through the vaginal wall. The patient received 500 cc. of whole blood, 500 cc. of plasma and 250 cc. of saline. Although stimulants were given, the patient grew worse and died seven hours after operation. The postoperative diagnosis was left tubo-ovarian abscess and right infected ruptured ectopic pregnancy; perisigmoid abscess.

The pathologic report revealed the following: Anatomically, the specimen was a resected tube and ovary. The tube was considerably elongated and dilated. There was extensive rupture of the entire wall exposing the dilated lumen which was occupied by an intact placenta and an amniotic sac containing a fetus, 7.5 cm. crown-rump length. There was an extensive hematoma of the tissues of the tube through the line of rupture. The ovary presented a few capsular adhesions and on section showed nothing noteworthy except a large corpus luteum. Histologically, the lumen of the tube was occupied by blood and placental tissue embedded in the wall. The latter showed a chronic inflammatory reaction but no evidence of a suppurative process. The ovary showed a few capsular inflammatory fibrous adhesions and a large corpus luteum.

The diagnosis was ruptured tubal pregnancy; chronic salpingitis; perisigmoid abscess.

The autopsy findings were as follows: Upon opening the peritoneal cavity large, old blood clots dispersed throughout were found. A right salpingo-oophorectomy had been done. The uterus and left tube and ovary were present, the left tube and ovary forming a large mass. There were adhesions between the liver and hepatic flexure of the colon and between the liver and diaphragm.

The uterus was moderately enlarged, congested and of soft consistency. No fibromyomas were present. The increased size was due to a somewhat increased thickness and edema of the myometrium. The uterine cavity was moderately enlarged. The endometrium was smooth throughout, of distinctly increased thickness and showed striking vascular injection. The right tube and ovary had been removed. A few bits of blood clot were adherent but the broad ligament was otherwise clean and showed no evidence of a bleeding point. The left tube and ovary were markedly enlarged and fused to form a large tubo-ovarian mass into which the ovary was completely incorporated. The tube was considerably thickened and the lumen dilated and filled with greenish purulent fluid. There was a small perforation in the postero-inferior aspect of the mass from which purulent fluid escaped into a small space formed by the mass anteriorly and the coils of rectosigmoid posteriorly. The serosal aspect of the rectosigmoid thus formed part of the wall of this abscess cavity and was covered by a greenish necrotic membrane. There was no extension of this process to any other portion of the peritoneum. The remainder of all the serosal surfaces was smooth, thin and glistening.

CASE II. C. R., a negress aged twenty-eight, was admitted to the hospital December 9, 1944, in acute distress. She was pale, her skin was cold and dry and she complained of severe abdominal pain and fainting. For six days prior to admission the patient had had intermittent spotting. On the day before admission she had had abdominal pain and further spotting. Four hours before admission

she had severe abdominal pain followed by three episodes of syncope.

The patient was gravida I, para o. Her last menstrual period occurred on September 23, 1944. The patient's menstrual history could not be obtained because of her serious condition; venereal infection was denied.

Abdominal examination revealed exquisite direct tenderness throughout, with light rebound tenderness. Pelvic examination revealed vaginal tenderness throughout. The uterus could not be felt; there was bulging tenderness in all fornices. A fluid wave was observed.

Laboratory findings revealed the following: Hemoglobin 42 per cent; red blood cells 1,600,000; white blood cells 18,850; band neutrophils 16 per cent; segmented neutrophils 80 per cent; lymphocytes 2 per cent; monocytes 2 per cent. Sedimentation rate 7 mm. Temperature 97.4°F.; pulse very weak; blood pressure 100/50; respirations 24. The urine showed 18 to 20 white blood cells, with occasional clumps and occasional red blood cells. Preoperative diagnosis was intra-abdominal bleeding.

Laparotomy was performed under cyclopropane anesthesia one and one-half hours after admission. Infusion of saline and plasma was started during the operation. There was at least 1 L. of fluid and clotted blood in the peritoneal cavity. The right tube was ruptured 2.5 cm. from the uterine end. In this area there were active bleeding and a mass of soft friable tissue about the opening. Operation was completed and dressings were applied. During the operation the patient's condition was poor. She had a very small, rapid pulse which showed some improvement following infusion of, a few hundred cc. of solution. Oxygen was administered as the anesthesia was terminated. As the patient was being straightened out of the Trendelenburg position for removal to her room no pulse or blood pressure could be obtained. All efforts to revive the patient failed and she expired. Postoperative diagnosis was right ruptured tubal pregnancy; chronic salpingitis.

The pathologic report revealed the following: Anatomically, the specimen was reported to be a right tube and ovary, but could not be recognized grossly as such. It consisted of firm, whitish tissue with brownish friable areas which appeared to be hemorrhagic. Histologically, the sections showed fibromuscular tissue with signs of chronic inflammation, invaded by chorionic villi. There was no mucosal lining but in other areas a cross section of the tube showed the mucosal folds lined by cylindrical epithelium. There were areas of hemorrhage; no ovarian stroma was seen.

CASE III. L. D., a white female aged twenty-eight, was admitted to the hospital on February 11, 1936, in moribund condition. Her complaints on admission were amenorrhea of six weeks' duration and sharp pain in the lower abdomen eight hours before admission. She had been seen by two other physicians prior to admission. Menstrual and obstetric history could not be obtained.

Physical examination revealed abdominal tenderness with slight rigidity of the lower abdomen. A definite fluid wave was observed. The patient was in shock, practically pulseless, with air hunger. The heart sounds were poor in quality. Pelvic examination revealed an indefinite mass in the left cul-de-sac. The cervix pointed in the axis of the vagina. The cervix, which was firm, produced exquisite pain on motion. There was extreme tenderness in both fornices. It was impossible to map out the uterus. There was a white vaginal discharge but no bleeding.

Hemoglobin was 55 per cent; red blood cells 2,850,000; temperature 95°F.; pulse was practically nil. Preoperative diagnosis was left ruptured ectopic pregnancy. At operation, twenty-five minutes after admission to the hospital, a left salpingectomy was performed. The peritoneal cavity was full of blood and the left tube was ruptured. Saline solution and blood were administered intravenously as soon as the bleeding vessels had been clamped. In spite of stimulation the patient expired as the operation was being completed.

Postoperative diagnosis was left ruptured ectopic pregnancy.

The pathologic report disclosed that a cross section of the fallopian tube showed the lumen to be almost entirely obliterated. Microscopic examination of hemorrhagic tissue revealed numerous chorionic villi.

CASE IV. V. S. Refer to Case IV under Case Reports.

CASE V. V. M., a negress aged thirty, was admitted to the hospital on June 30, 1939. She appeared to be in shock. She complained of twelve days of amenorrhea followed by spotting. One week prior to admission she had experienced severe pain in the right lower quadrant which recurred on the morning of admission; at this time the pain extended over the entire lower abdomen. She perspired and experienced weakness and faintness. The patient also complained of a feeling that "something was growing" in the right side of her abdomen. She noticed that her hands were getting pale. Previously she had had antiluetic treatment.

The patient was gravida IX, para VIII. She had had no miscarriages. Her menses began at fourteen and occurred every thirty days. The last normal menstrual period was on April 19, 1939.

Abdominal examination revealed marked direct and rebound tenderness over the entire lower abdomen. There was a sense of resistance and an

indefinite mass in the lower abdomen, especially on the left side.

Pelvic examination showed no blood in the vagina. There was marked tenderness on motion of the cervix. The uterus could not be mapped out because of the presence of an indefinite mass which seemed to fill the entire pelvis, reaching to 5 cm. above the symphysis pubis and bulging into the cul-de-sac. Pressure against the latter elicited marked pain.

Hemoglobin was 50 per cent; red blood cells 2,520,000; white blood cells 13,900; band neutrophils 21 per cent; segmented neutrophils 65 per cent; lymphocytes 12 per cent; monocytes 2 per cent. The Klein test was negative. Tissue expelled from the vagina showed decidual reaction. The preoperative diagnosis was ruptured ectopic pregnancy.

At operation right salpingectomy for ruptured tubal pregnancy was performed on June 30, 1939, under nitrous oxide and ether anesthesia. The blood was left in the abdomen. The patient received 750 ec. of normal saline solution and 5 per cent glucose during the operation. This was followed by 500 cc. of blood. Two blood transfusions of 500 cc. were given.

Postoperatively the patient developed marked distention and her temperature rose to 105°F. She died on the fifth postoperative day. Postoperative diagnosis was right ruptured tubal pregnancy.

Postmortem examination on July 5, 1939, revealed dilated loops of small intestine. There were no signs of peritonitis. The peritoneum was glistening, not reddened. The peritoneal cavity contained old blood. The sutures were all intact and the abdominal wound was firm. The postmortem diagnosis was paralytic ileus of unknown origin.

The pathologic report stated that the tube measured approximately 11 cm. in length. The proximal third was of relatively normal width although apparently slightly thickened and covered by fibrous adhesions. The distal two-thirds was markedly expanded; the wall was thickened and extensively torn and the lumen contained a ragged placental structure. The fetus measured 5.2 cm. crown-rump length.

Histologically, the sections showed a thickened, chronically inflamed tube with placental tissue embedded in the mucosa in one area. Postmortem culture of the peritoneal fluid revealed no growth; smears were negative.

CASE REPORTS

The following case histories represent patients who were operated upon for ectopic gestation and secondary abdominal pregnancy.

CASE I. A. A., a thirty-eight year old nullipara, was admitted to the hospital January 31, 1946, because of vaginal bleeding. Three weeks prior to admission the patient had noted spots of blood during one day; this was at the expected time of menstruation. Tens days before admission the spotting recommenced and persisted; it was accompanied by intermittent hypogastric pain radiating down the right thigh.

Menses began at ten years and occurred at intervals of twenty-eight days, with a duration of three days. The seven menstrual periods preceding the present illness were normal, the last one occurring on December 7, 1945. Prior to this there was a term of four months during which the patient had bled twice each month.

Physical examination revealed some tenderness over the suprapubic region. Pelvic examination revealed blood exuding from the cervical canal. The uterus was anteflexed, slightly enlarged, firm and movable. The cervix was directed downward and forward in the axis of the vagina. The right adnexa was tender. In the isthmus of the right tube, about 2 cm. from the cornu, a slight thickening was palpated.

Laboratory findings revealed that the hemoglobin was 90 per cent; red blood cells 4,490,000; white blood cells 8,800; band neutrophils 4 per cent; segmented neutrophils 59 per cent; lymphocytes 30 per cent; monocytes 6 per cent; eosinophils 1 per cent. Urinary findings were essentially negative. The Friedman modification of the Aschheim-Zondek test was negative when first done, but the report of a second test received after operation was positive.

Preoperative diagnosis was (1) ectopic pregnancy; (2) fibrosis of the uterus.

On her fourth day in the hospital (February 3, 1946), the patient felt faint and her pain became sharper. Laparotomy fifteen minutes later revealed fresh blood in the peritoneal cavity. The proximal third of the right tube was thick and a small hole was found on the postero-inferior aspect from which blood was pumping. The right tube was excised. Convalescence was untroubled.

Postoperative diagnosis was right ruptured tubal pregnancy at the proximal end of the isthmus.

The pathologic report was as follows: Anatomically, the specimen was a resected tube measuring 5 cm. in length. Resection was at the proximal portion of the isthmus of the tube. The diameter at the point of resection was 1 cm. A short distance from the resected surface the wall showed a ragged opening from which clotted blood and placental tissue protruded. The opening measured 0.7 cm. in diameter. Distally from the enlarged area the tube was of normal size and appearance.

Histologically, the section through the distal portion showed an essentially normal tube. Section through the ruptured area showed placental

tissue attached to and infiltrating the tubal wall. Decidual reaction was present.

Section through the areas on both sides of the rupture showed a narrow, uninvolved lumen of the tube and extensive hemorrhagic infiltration of the wall with chorionic villi in one section.

Diagnosis was ruptured right tubal pregnancy at the proximal portion of the isthmus.

CASE II. J. M., a woman aged thirty-four, was admitted to the hospital January 19, 1946, because of severe abdominal pain and vomiting. This occurred during coitus. She was gravida VI, para I. Menses began at twelve years and occurred every twenty-eight days, with one day duration. The flow was scanty. The last normal menstruation began November 15, 1945. The patient had had spotting for three and one-half weeks and hypogastric pain for six days. The spotting had begun on December 24th, nine days after a missed menstrual period. Incidental complaints were dysuria, urinary frequency and hematuria. Physical examination revealed the abdomen to be tender and markedly distended.

On vaginal examination the cervix was found to be painful on motion. The left fornix was somewhat rigid; no masses were palpable. Re-examination five days later revealed the presence of an elastic mass in front and to the left of the uterus. The fundus could not be outlined. The Aschheim-Zondek test was positive.

Laboratory findings were: Hemoglobin 68 per cent; red blood cells 3,740,000; white blood cells 12,600; band neutrophils 26 per cent; segmented neutrophils 64 per cent; lymphocytes 8 per cent; monocytes 2 per cent. Sedimentation rate 4 mm. Temperature 99.2°F.; pulse 78. Smears were negative for gonococci and the serology tests were negative. Preoperative diagnosis was ectopic pregnancy. At operation a left salpingectomy was performed.

Pathologic Report. (Figs. 2 to 8.)

In this case the rupture occurred on the day of operation. Report of the Aschheim-Zondek test received after the operation was positive. The menstrual age of the fetus was ten weeks.

CASE III. E. C., a woman aged twenty-eight, was admitted to the hospital December 5, 1945, because of faintness and severe abdominal pain, which was most marked in the right lower quadrant. She was gravida II, para I. The patient reported a history of cesarean section ten years previously and an induced abortion five years prior to admission. She stated also that she had had a "pelvic inflammation and right tube infection" four years previously. On November 2, 1945, she had been admitted to another hospital with a complaint of abdominal pain and vaginal bleeding of three days' duration. At that time she

was informed that she had a fibroid uterus and was pregnant.

Menses began at thirteen years and occurred every twenty-eight to thirty days, with a duration of five to six days. The flow was profuse. Occasional irregularity included two periods of amenorrhea of six weeks' duration during the decade immediately preceding admission. The last normal menstrual period occurred on September 22, 1945. Immediately after this menstrual period she had four weeks of vaginal bleeding and two weeks of pink, vaginal discharge.

Physical examination revealed the patient to be weak and pale. The abdomen was distended and tender, especially in the hypogastrium. There was shifting dullness in the flanks. On vaginal examination the cervix was found to be tender on motion. The uterus was the size of an eight weeks' gestation and very tender on motion. The adnexae and posterior fornix were very tender but no mass was palpated.

Laboratory findings were: Hemoglobin 39 per cent; red blood cells 2,140,000; white blood cells 13,800; band neutrophils 20 per cent; segmented neutrophils 61 per cent; lymphocytes 15 per cent; monocytes 4 per cent. Sedimentation rate was not recorded. Serology tests were negative.

Preoperative diagnosis was ruptured ectopic pregnancy.

Laparotomy was performed December 5, 1945. The peritoneum contained about 1 L. of blood. The uterus was about the size of an eight weeks' pregnancy and contained several small fibroids. In the right horn there was a protuberance about 3 cm. in diameter which had a ragged tear. The latter was bleeding profusely. In the abdominal cavity near the rupture lay a 2.5 cm. fetus and placental tissue. Because of the proximity of fibroids to the point of rupture, excision of the right cornu was impossible. Consequently, subtotal hysterectomy and partial right salpingectomy were performed. (Figs. 9 to 13.) The fetus had a menstrual age of seventy-four days.

Postoperative diagnosis was ruptured right interstitial pregnancy and fibromyomas of the uterus.

The pathologic report was as follows: There was a uterus with ruptured interstitial pregnancy on the right side and fibromyomas. Microscopic examination of a section from the cornu showed a crater-like depression in the myometrium with chorionic villi burrowing into it. There was no endometrium and no decidual reaction. Tubal mucosa was noticed near this area.

CASE IV. V. S. The patient, thirty years old, gravida II, para I, was admitted to the hospital December 5, 1945, with a complaint of continuous low abdominal pain of three weeks' duration. She also had occasional vaginal bleeding. The bleeding

Fig. 23. Case vii, P. F. Abdominal pregnancy; roentgenogram shows presence of fetus; it was impossible to be certain whether this represented an abdominal or an intra-uterine pregnancy. In the right iliac fossa there is a vague outline which can be seen (slightly retouched) crossing the vertebral column. Toward the left this outline disappears. It subsequently proved to be the outline of the fetal sac. The fetal head is small for a postmature baby; the cranial bones overlap. These signs indicate fetal death.

stopped after eight days but the abdominal pain continued until admission to the hospital. The night prior to admission the patient experienced severe epigastric pain, vomiting and fainting which continued to the time of admission. Vomitus contained blood. There was an icteric tinge of sclera and cervix. Tenderness and rigidity were present over the entire abdomen, maximal in the left lower quadrant. The patient had had one full-term preg-

nancy in 1932. In the intervening years there were no abortions and she did not use contraceptives. Menses began at twelve years and occurred regularly every twenty-eight days, with three days' duration. The flow was moderate and not painful. The last normal menstrual period occurred August 21, 1945. Ten days later she noted a few stains.

Pelvic examination revealed a long, thin and
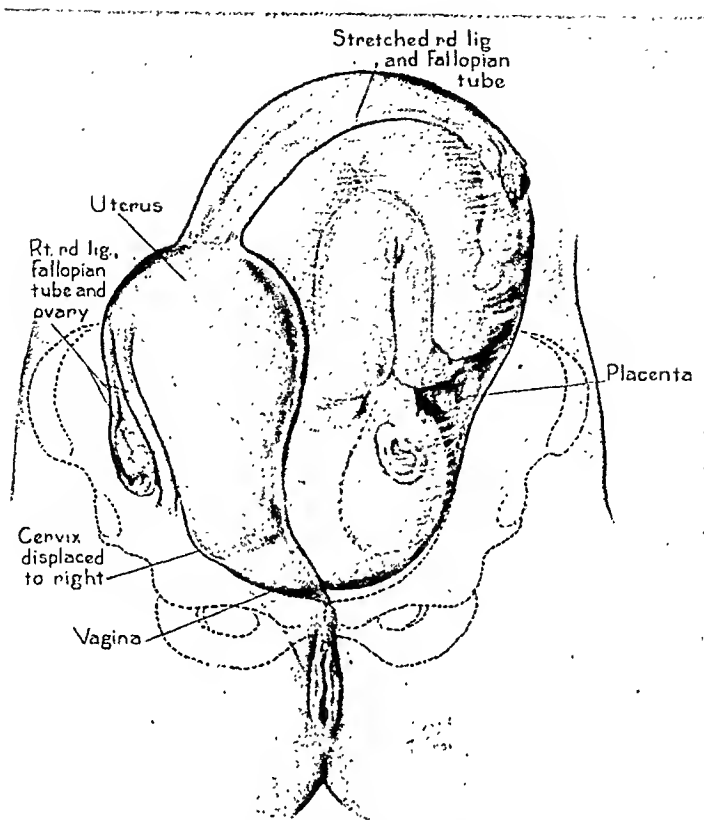
FIG. 24. Case VII, P. F. Schematic drawing of abdominal pregnancy, anterior view. Uterus is pushed to the right. The sac covers half of anterior surface and left side of uterus. The dorsum of the fetus is posterior to the rotated uterus. The stretched left round ligament and left fallopian tube pass over top of sac; membranes are not ruptured. The placenta is attached to the left lateroposterior wall of pelvis. The cervix is pushed up above left pubis, the vagina stretched out. The cervical os could not be reached with a sound because of the upward displacement of the uterus.

softened cervix. An indefinite hard mass filled the whole of the tender parametrium. Re-examination after an interval of three days revealed the presence of a firm mass 2 cm. in diameter on the left side of the uterus. From the cervix an elastic mass extended upward to the umbilicus.

Laboratory findings were: Hemoglobin 50 per cent; red blood cells 3,020,000; white blood cells 12,000; band neutrophils 11 per cent; segmented neutrophils 74 per cent; lymphocytes 12 per cent; monocytes 2 per cent; basophile 1 per cent. Sedimentation rate 16 mm. Temperature 98.6°F.; pulse 98; blood pressure 124/72. Serology tests negative. Aschheim-Zondek test positive. Urine showed granular casts and pus cells in clumps.

Preoperative diagnosis was abdominal pregnancy.

Laparotomy was performed on December 8, 1945. The abdominal cavity contained a large quantity of old blood. There were organized clots in the iliac fossae and hypochondrium. The slightly enlarged uterus was pushed to the right and covered by a mass which extended anteriorly, posteriorly and to the left. This mass ruptured spontaneously during operation. It proved to be an abdominal pregnancy roofed over by the left tube and ovary. (Fig. 15.) The patient received intravenous saline and glucose followed by 500 cc. of blood.

Pathologically, the specimen consisted of a fetal sac, the wall of which was formed to a great extent by a fallopian tube. Ovarian tissue was also recognized in the wall of the sac. The fetus was 9 cm. long; it showed movements. Its menstrual age was 110 days. Roentgenogram of the fetus showed ossification centers in diaphyses of all the long bones of the hands and feet. Nails were observed. (Fig. 16.) It was believed that the pregnancy had commenced in the tube and had subsequently ruptured (probably about the middle of November, three weeks prior to admission) into the abdominal cavity and continued as an abdominal pregnancy.

Subsequently, on the second postoperative day, the patient became somewhat distended but the abdomen was soft and her condition good. On the

third postoperative day she began to vomit. The following day she became markedly icteric and developed diarrhea. In spite of all measures the patient became progressively worse and died on December 17, 1945, nine days following operation. The cause of death was hepatorenal syndrome.

Autopsy showed old blood clots in the hypochondrium and iliac fossae, fatty degeneration of the liver, tubular degeneration of the kidneys, paralytic ileus, pulmonary edema and acute passive congestion of the spleen.

CASE V. O. G., a woman aged twenty-one, was admitted to the hospital December 9, 1946, because of prolonged menstrual periods. She was gravida II, para I. Menses began at fourteen years and occurred every twenty-eight days, with five days' duration. Periods were usually on time and normal. The last normal menstrual period began October 15, 1946. On November 9, 1946, three days before time, she began to menstruate. Bleeding continued for seven days (until November 15th). Six days later (November 21st) the patient had a sudden attack of pain in the left lower quadrant. She was treated at another hospital for "inflamed tubes." On November 29, 1946, the patient started to bleed again. At no time did she complain of dizziness or fainting. She signed herself out of that hospital. On December 9, 1946, when admitted to the hospital, abdominal examination revealed a mass on the right side arising from the pelvis and extending to 7 cm. below the umbilicus. On the left side this mass extended to 5 cm. below the umbilicus. Vaginal examination revealed a normal-sized uterus which was pushed forward toward the symphysis by a cystic mass which was behind and to the left of the uterus.

Laboratory findings were: Hemoglobin 70 per cent; red blood cells 4,650,000; white blood cells 5,900; band neutrophils 6 per cent; segmented neutrophils 56 per cent; lymphocytes 38 per cent. Sedimentation rate 5 mm. Serology tests negative. Temperature 98.6°F.; pulse 84; respirations 20; blood pressure 110/80. Preoperative diagnosis was left ovarian cyst.

Laparotomy was performed on December 12, 1946. The left tube was removed because of hematosalpinx. Both ovaries were normal. Postoperative diagnosis was left hematosalpinx.

Upon pathologic examination the sections showed considerable chronic inflammatory reaction and thickening of the tubal wall. There was blood in the lumen even where the latter was not dilated. Sections of the wall from the dilated portion showed chronic inflammation and fibrosis. The mucosa was replaced by granulation tissue with adherent blood clot. In the blood clot from the lumen there were typical chorionic villi most of which were degenerated or necrotic. (Figs. 17 and 18.)
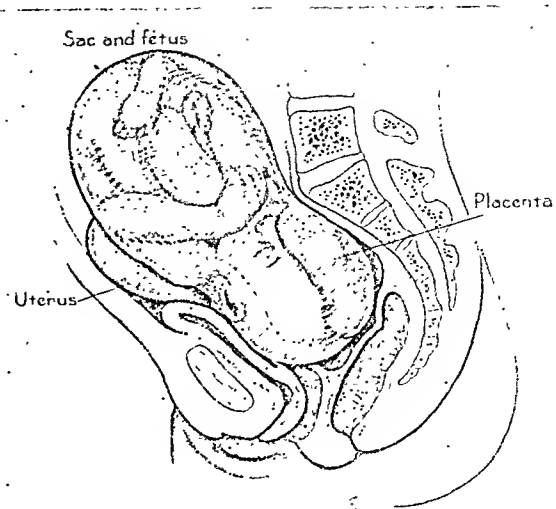
FIG. 25. Case VII, P. F. Schematic drawing of abdominal pregnancy, sagittal section. The reader is looking toward right side after removal of left half of the pelvic skeleton; note left edge of uterus. Bladder is compressed; the placenta was adherent to the removed left part of sacrum and pelvic wall. The right side of the face of fetus is in contact with placenta; membranes are not ruptured.

Pathologic diagnosis was tubal pregnancy associated with hematosalpinx and marked chronic salpingitis.

CASE VI. V. M., a primigravida aged twenty-six was admitted to the hospital on February 16, 1944, complaining of peri-umbilical pain and spotting. She reported that she was pregnant four and one-half to five months. Menses began at thirteen years and occurred every twenty-eight days, with five to seven days' duration. The flow was moderate, but there was much pain. The last menstrual period occurred on October 19, 1943, (four months before admission to the hospital), at which time the patient began to have peri-umbilical pain and vaginal spotting, but no vomiting or nausea.

Physical examination revealed the abdomen to be tender throughout, especially in the lower quadrants. The fundus was palpable at the level of the umbilicus. A mass about 6 cm. was detected half-way between the umbilicus and the symphysis. The introitus was nulliparous. On vaginal examination the cervix was in the axis of the vagina. A soft mass was found in the right fornix and cul-de-sac. On further examination it seemed that this mass was continuous with the abdominal mass which appeared to be the pregnant uterus while the firm mass palpated abdominally might be the fundus. Hence there was a possibility of abdominal pregnancy or an intraligamentous cyst on the right side. The mass in the cul-de-sac could not be assumed to be the remains of a pelvic exudate since there was no history of an old
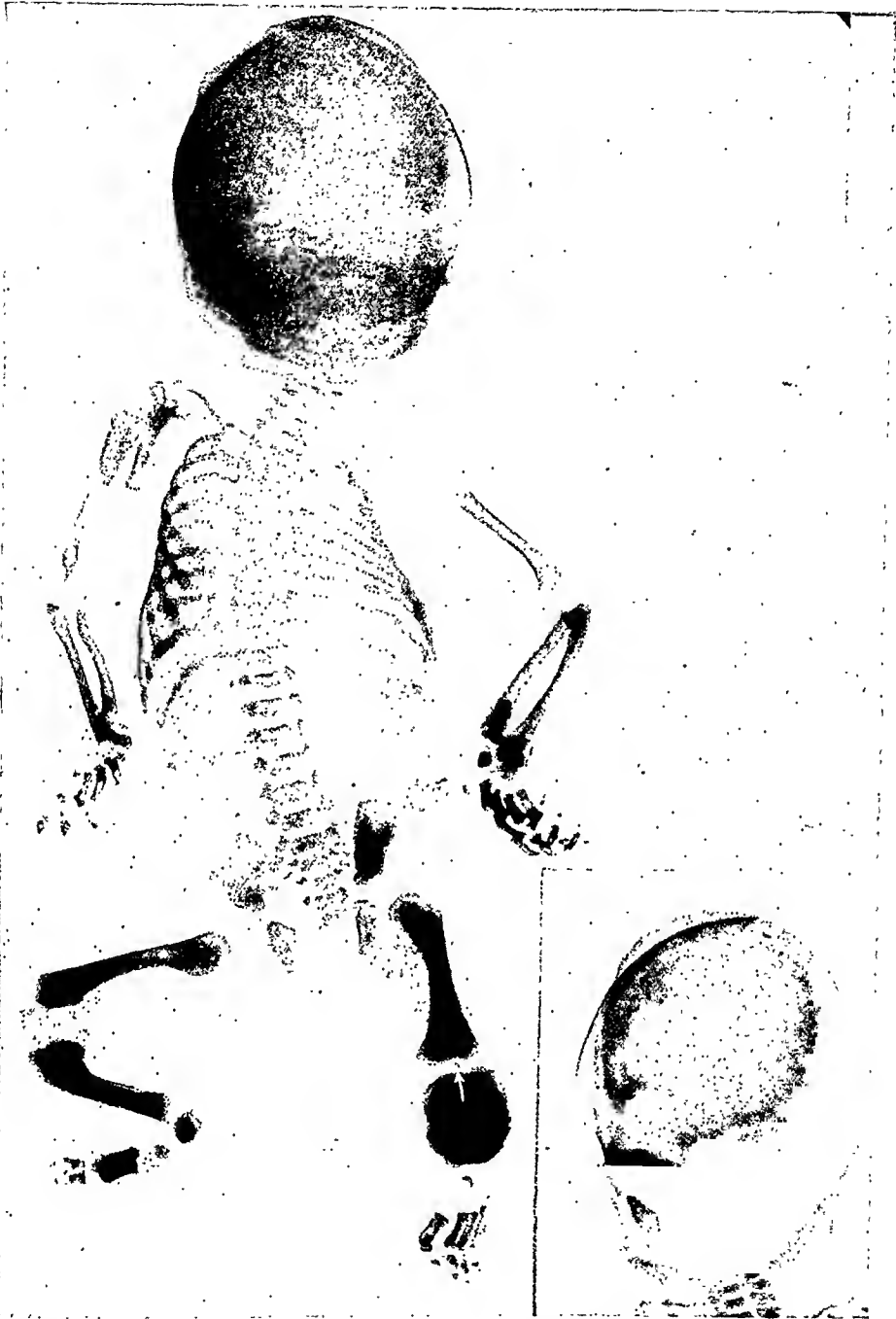
FIG. 26. Case VII, P. F. Abdominal pregnancy; roentgenogram of dead fetus. Last normal menstruation of mother July 15, 1944. Patient ceased to feel life April 30, 1945, at menstrual age of 289 days. Menstrual age of fetus at operation, May 15, 1945, was 304 days. Note ossification centers at distal epiphyses at femora; these ordinarily appear at term. Fetus evidently died nine days postmaturity. See overlapping of cranial bones (note insert especially) indicating death of fetus.

inflammatory process and it was highly improbable that conception could occur in the presence of an exudate of this size.

Roentgenogram showed that the fetus lay transversely, the head pointing to the left, the vertebral column downward and the ribs upward. The frontal region of the skull showed a protuberance. (Fig. 19.)

Laboratory findings were: Hemoglobin 75 per cent; red blood cells 3,880,000; white blood cells 5,800; band neutrophils 8 per cent; segmented neutrophils 57 per cent; eosinophils 2 per cent;
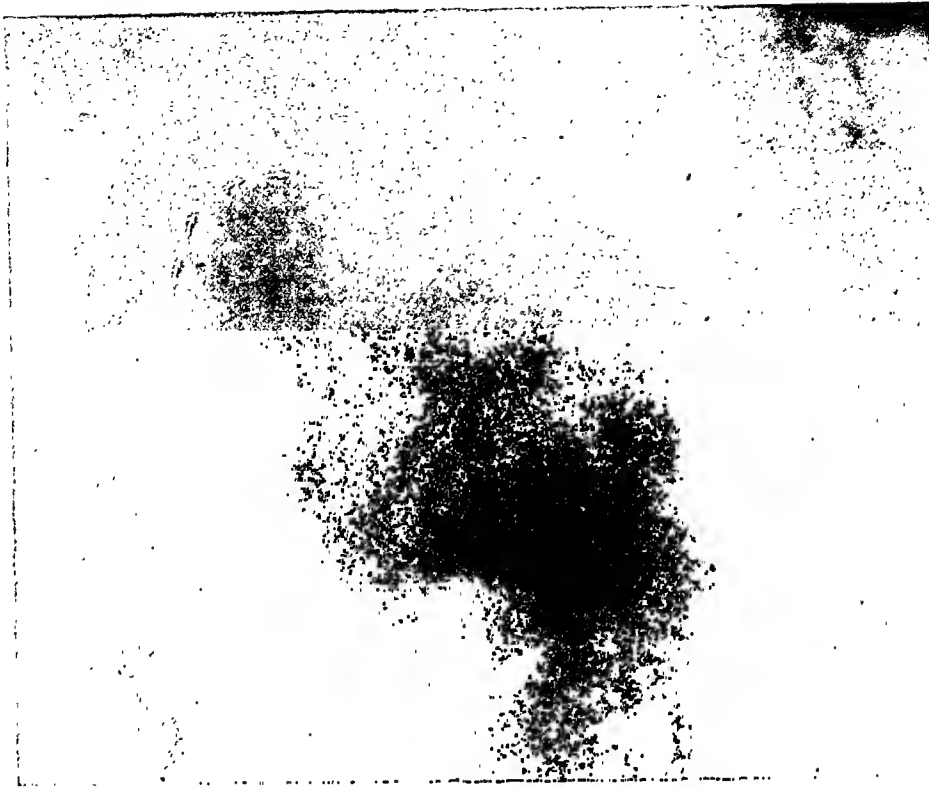
FIG. 27. Case VIII, A. L. Roentgenogram of abdomen; fetal head shown in right upper abdomen (reader's left). Note that the head is slightly retouched in its lower part and outlined with arrows in its upper part.

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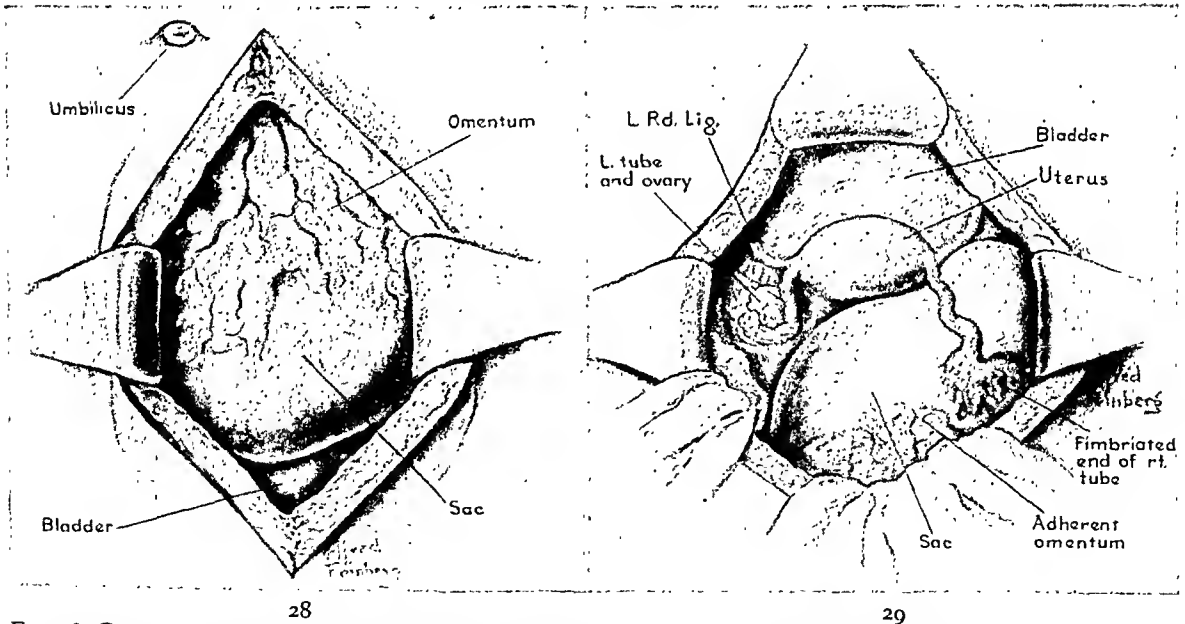
FIG. 28. Case VIII, A. L. Abdominal pregnancy; the abdomen has been opened. The omentum has been separated from the lower pole of the sac and drawn upward. The sac, which contains the fetus, has not yet been opened.

FIG. 29. Case VIII, A. L. Abdominal pregnancy; patient in Trendelenburg position. The lower righthand portion of the field is occupied by the sac, into which the distal third of the right fallopian tube and its fimbriated end are incorporated. The right ovary is hidden beneath the sac.
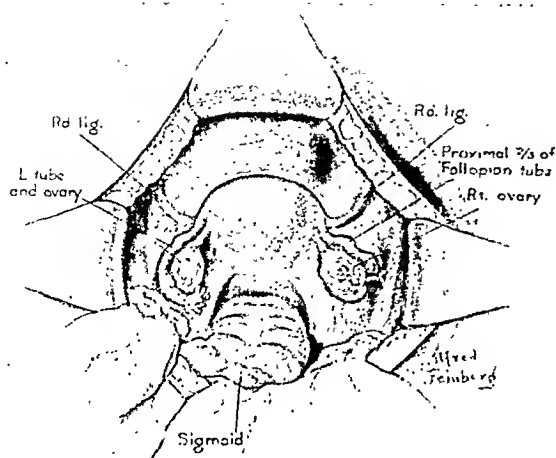
FIG. 30. Case VIII, A. L. Abdominal pregnancy; internal genital organs after removal of sac which contained fetus; patient in Trendelenburg position. Note uterus, round ligaments, stump of right fallopian tube, right ovary, left fallopian tube, left ovary and sigmoid.
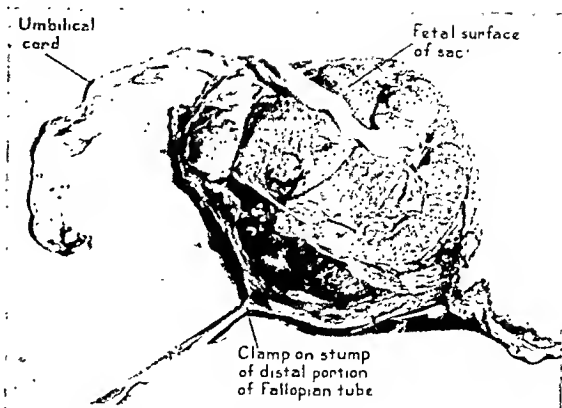
FIG. 31. Case VIII, A. L. Abdominal pregnancy; photograph of fetal surface of sac. Note clamp on stump of distal portion of right fallopian tube.

The mass and the appendix were removed. Postoperative diagnosis was abdominal pregnancy.

Pathologically, the mass proved to contain a male fetus having a crown-rump length of 14.5 cm. The conformation of the head was abnormal,
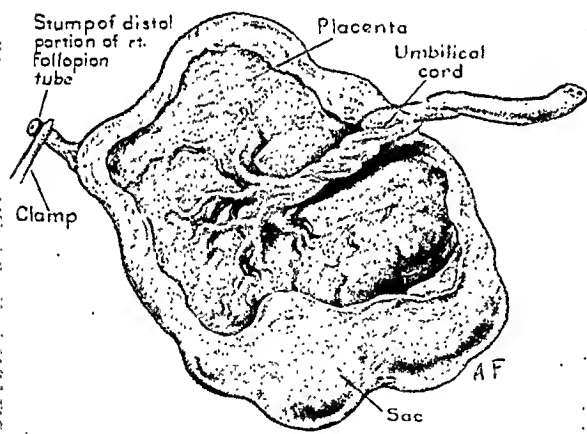
FIG. 32. Case VIII, A. L. Schematic drawing of abdominal pregnancy; fetal surface of sac seen through rent. Stump of distal portion of right fallopian tube as seen from the fetal surface.
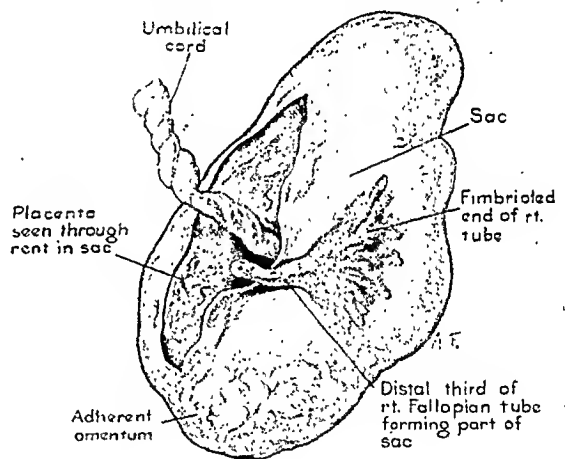
FIG. 33. Case VIII, A. L. Schematic drawing of abdominal pregnancy; maternal surface of sac. Distal one-third and fimbriated end of right fallopian tube forming part of sac; the remains of omentum adherent to lower pole of sac; placenta seen through rent in sac; umbilical cord.

lymphocytes 27 per cent; monocytes 6 per cent Sedimentation rate 15 mm. Serology tests were negative. Temperature 98.8°F.; pulse 80; blood pressure 110/65. Preoperative diagnosis was abdominal pregnancy.

Laparotomy revealed the uterus to be the size of a three or four months' gestation; many fibroids were present. The isthmus of the right tube led to a large reniform hemorrhagic cystic mass which hugged the right side of the uterus and extended into the cul-de-sac over to the left side of the pelvis; it was adherent to the appendix and meso-appendix.

there being a protrusion in the frontal region which was detectable through the surrounding tissues of the excised surgical specimen. (Figs. 20 and 21.) The fetal sac contained both ovarian and tubal tissue.

Roentgenogram of the fetus revealed ossification centers in the arches of the eleven uppermost vertebrae and in the phalanges of the hands. No ossification center was seen in the horizontal ramus of the pubis. Hence the age of the fetus was taken to be less than twenty weeks. (Fig. 22.) The

menstrual age of the fetus was 133 days, or nineteen weeks.

CASE VII. P. F., aged twenty-eight, was admitted to the hospital on May 2, 1945, complaining of cessation of fetal movements and a mild abdominal pain of two days' duration. She was gravida III, para II.

Menses began at thirteen years and occurred every twenty-eight days, with three days' duration. The character was normal. The last menstrual period began July 15, 1944. In both her previous pregnancies the patient had had toxemia and in each instance was delivered of a full-term baby which survived only a few minutes. She had had
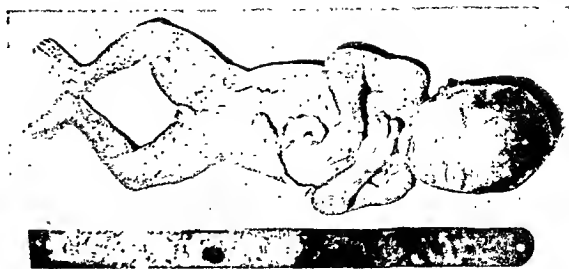
FIG. 34. Case VIII, A. L. Abdominal pregnancy; photograph of fetus; weight 1 pound, 13 ounces; crown-heel length 32 cm.; menstrual age twenty weeks.

occasional treatments for syphilis during the last five years.

Physical examination revealed that the fetal heart was inaudible. What seemed to be the fundus was palpable 2 fingerbreadths above the umbilicus. On rectal examination the vertex was found at station plus 1. The cervix could not be found. Roentgen examination showed that the fetal head was small and that the bones of the skull were beginning to override. The vertebral column had collapsed. It was inferred that the fetus was dead. By vaginal examination it was found that the head lay far in the posterior cul-de-sac and reached approximately to the sacrococcygeal articulation.
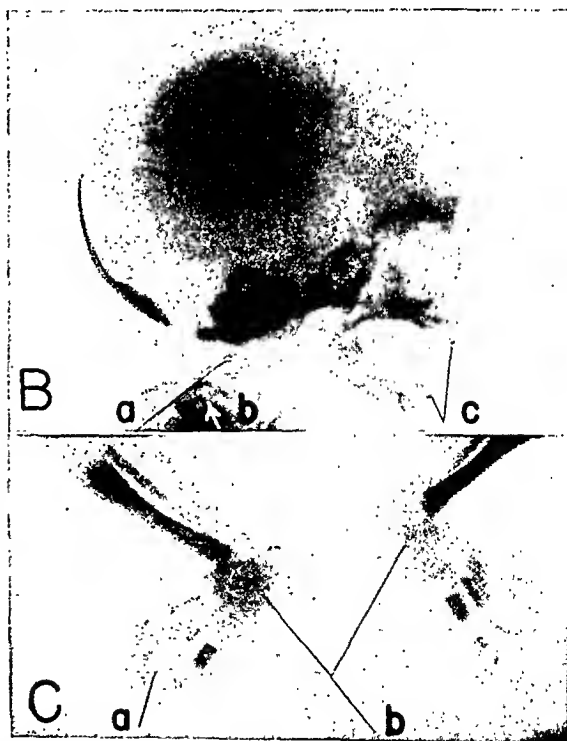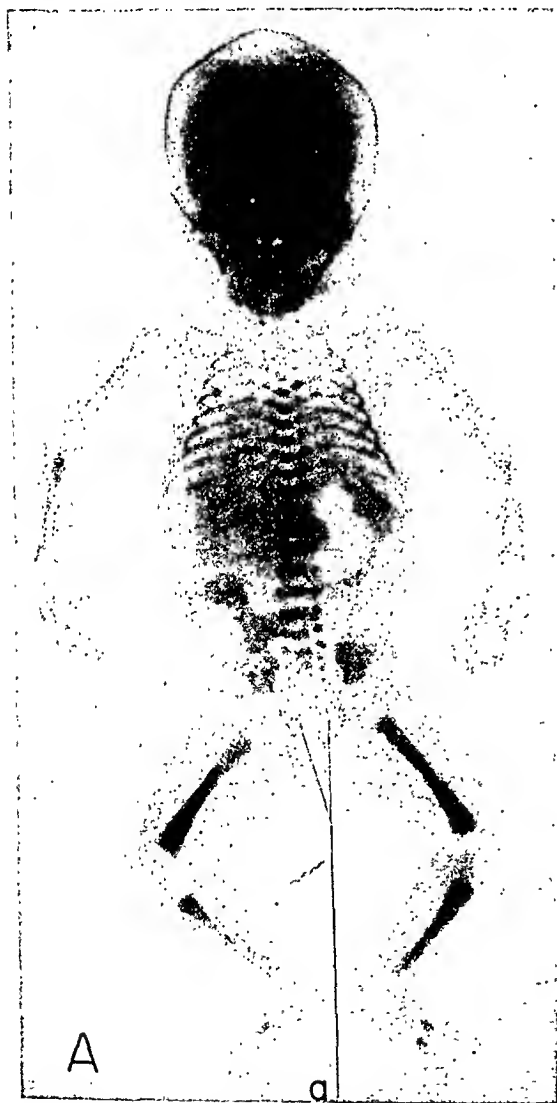
FIG. 35. Case VIII, A. L. Abdominal pregnancy. Date of last normal menstruation not certain from history (June 16 or July 16, 1945); operation November 8, 1945. A, (a) horizontal rami of pubis appear not before 20th week. B, (a) ossification center of odontoid process of axis 20th week; (b) arches of vertebrae 20th week; (c) incisors of deciduous teeth. C, (a) Ossification of middle phalanx of second toe 20th week; (b) os calcis absent; fetus less than twenty-two weeks. According to ossification centers the menstrual age of fetus is 145 days; hence correct date of last normal menstruation must have been June 16, 1945.

FIG. 36. Case IX, B. J. Abdominal pregnancy; cystogram after injection of 40 cc. of 12.5 per cent of aqueous solution of sodium iodide. Distance between fetal head and shadow of bladder was about 8 cm. This distance is too great for placenta previa. The probability of abdominal pregnancy was increased by this finding.
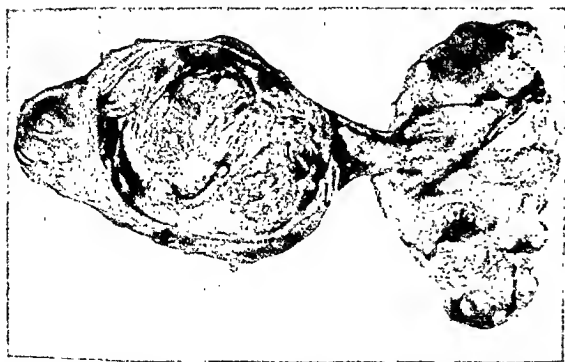
FIG. 37. Case IX, B. J. Abdominal pregnancy; photograph of extirpated fibromyomatous uterus and sac; the placenta was implanted in the ovary.

(Fig. 23.) The cervix was directed upward and to the right. The os could not be reached since it was above the upper margin of the pubis and could not be pulled down with a volsellum. (Figs. 24 and 25.) Consequently, roentgen-opaque media could not be introduced into the uterus. The preliminary impressions were: (1) Extra-uterine pregnancy; (2) sacculation of retroflexed uterus; (3) malformation (double uterus).

Laboratory findings were: Hemoglobin 65 per cent; red blood cells 3,320,000; white blood cells 10,400; band neutrophils 21 per cent; segmented neutrophils 59 per cent; eosinophils 2 per cent; lymphocytes 16 per cent; monocytes 2 per cent. Serology test positive.

Laparotomy on May 15 ,1945, revealed the pres-
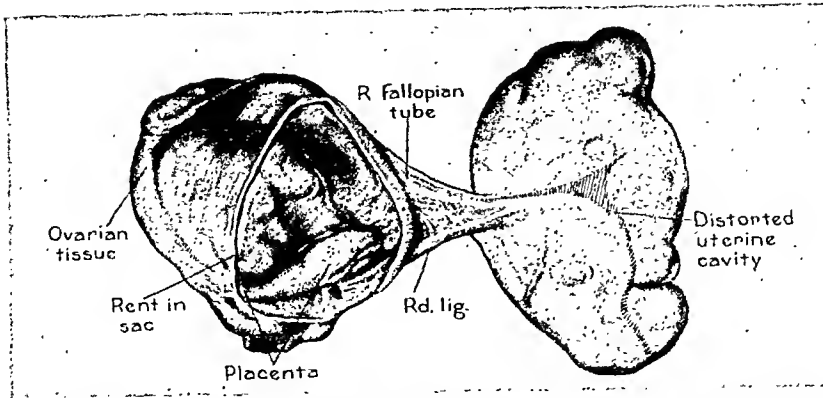
FIG. 38. Case IX, B. J. Abdominal pregnancy; schematic drawing of extirpated fibromyomatous uterus and fetal sac. Placenta is implanted in the ovary; shaded lines indicate distorted uterine cavity.

FIG. 39. Case IX, B. J. Abdominal pregnancy; photograph of living female baby. Observe pressure deformities of upper and lower extremities; note shriveled skin.
FIG. 40. Case IX, B. J. Abdominal pregnancy; same as Figure 39; posterior view. Note marked shriveling of soft tissues.

ence of a full-term extra-uterine fetus. The uterus was pushed to the right by a sac which covered half of the anterior surface as well as the left side of the organ. The left round ligament and left fallopian tube were stretched over the top of the sac. The placenta adhered to the left posterolateral wall of the pelvis. Hysterectomy and left salpingo-oophorectomy were performed. The fetus was macerated and weighed 6 pounds. The head to heel measurement was 44 cm. Roentgen examination revealed ossification centers at the distal epiphyses of both femora. The fetus therefore was alive at term. The mother no longer felt fetal movements when the menstrual age of the fetus was 290 days. At the time of operation the menstrual age was 305 days. Thus, the fetus had been dead at least fifteen days. (Fig. 26.) Postoperative diagnosis was abdominal pregnancy.

The maternal convalescence was complicated by thrombophlebitis of the left lower extremity. Recovery was complete by the time of discharge on June 11, 1945.

CASE VIII. A. L., a woman aged thirty-four, gravida III, para II, was admitted to the hospital on November 7, 1945, because of severe abdominal pain.

Menses began at twelve years and occurred every twenty-seven to thirty days, with three days' duration. The flow was profuse and there was much pain. The patient did not remember the exact date of her last menstruation but thought it was either June 16, 1945, or July 16, 1945, about twenty weeks before admission. Staining occurred thereafter on the date of each expected menstruation. Five days before admission the patient experienced sharp pain in the right upper abdominal quadrant and peri-umbilical region. The patient noticed a "rising" in her abdomen with each seizure of pain. On the day preceding admission bowel movements ceased and no flatus was passed. The abdomen became distended. Appendectomy had been performed seven years previously. Eructation and pyrosis had occurred for several years.

Physical examination revealed the patient to be acutely ill and in severe pain. The abdomen was much distended, especially in the lower quadrants and flanks. Rigidity was present in a marked

41A

41B
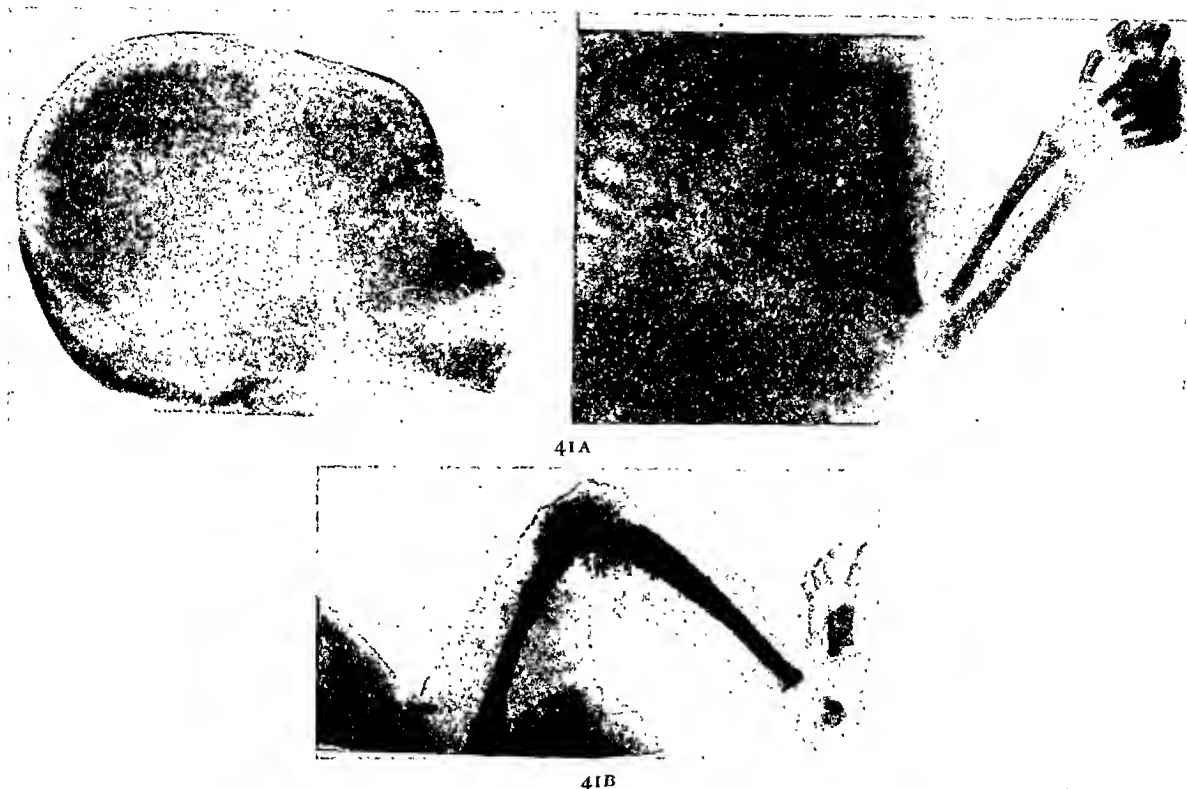
Fig. 41. A and B, Case IX, B. J. Abdominal pregnancy; roentgenogram of various parts of the baby's skeleton. Note ossification centers of distal epiphysis of femur, indicating that baby is at term. There is beginning of ossification center of the proximal epiphysis of tibia, which appears toward end of 40th or beginning of 41st week. Two ossification centers of os cuboideum are shown; these appear at about the same time. Ossification of rudimentary upper molars is visible.

degree. The cervix was softened. The uterus was soft and was outlined with difficulty; it appeared to reach the level of the umbilicus. In the right upper quadrant a very tender globular mass as big as a fist was discerned vaguely; it seemed to be connected with the uterus. Neither fetal heart sounds nor peristaltic sounds could be detected. It was thought that the patient had intestinal obstruction caused by torsion of a pedunculated fibroid or an ovarian cyst or adnexal mass. Extra-uterine pregnancy could not be excluded. A roentgenogram of the abdomen revealed the presence of fluid levels in the small intestines and a fetal head in the right upper quadrant. (Fig. 27.)

Laboratory findings were: Hemoglobin 59 per cent; red blood cells 2,880,000; white blood cells 10,800; band neutrophils 10 per cent; segmented neutrophils 70 per cent; lymphocytes 19 per cent; monocytes 1 per cent. Sedimentation rate 28 mm. Serology test positive. Temperature 99.2°F.; pulse 80; blood pressure 130/75.

Laparotomy on November 8, 1945, revealed the presence of distended loops of bowel and a cystic mass which proved to contain a living male fetus. The cystic mass was adherent to the omentum and to the distal third of the right fallopian tube. (Fig. 28.) The fimbriated end of the tube was

free but overlay the mass. (Fig. 29.) The right ovary was normal. The uterus was approximately the size of two months' gestation. The cystic mass and the distal third of the right tube were excised. The proximal two-thirds of the right tube, right ovary, the uterus and the left adnexa were left in place. (Figs. 30 to 33.) Soon after the operation the patient expelled flatus. She made a good recovery and was discharged as cured on the fourteenth postoperative day. The fetus weighed 1 pound, 13 ounces and had a crown-heel length of 32 cm. (Fig. 34.) From the ossification centers the fetus was judged to be about twenty weeks. (Fig. 35.) The patient's last menstruation, therefore, was June 16, 1945, and not July 16, 1945.

Postoperative diagnosis was abdominal pregnancy and intestinal obstruction.

CASE IX. B. J., a housewife, aged thirty-two, gravida II, para 0, was admitted to the hospital February 18, 1943, for induction of labor because of hypertension.

Menses began at twelve years and occurred regularly every twenty-eight days, with three days' duration. The flow was moderate and without pain until "three or four" years ago when she began to have pain the first few hours. With the onset of this pain the periods began to "stop and
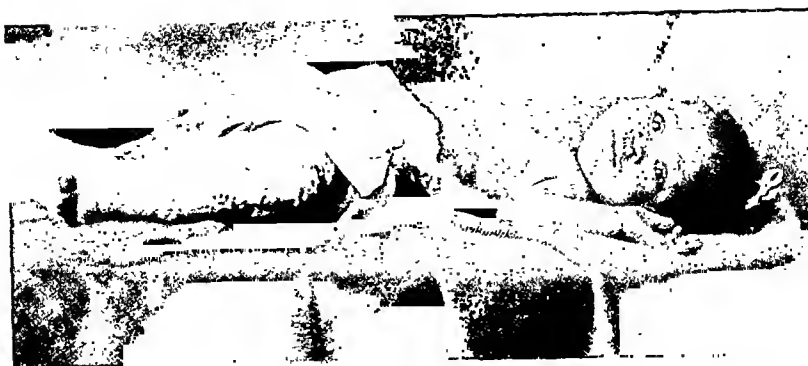
FIG. 42. Case IX, baby C. J., age thirteen months; child well developed mentally and has expressive eyes. The plaster casts are for the correction of bilateral pes valgus.

start." The last normal menstrual period occurred on May 17, 1942, the expected date of delivery being February 24, 1943.

Six days before term the patient was sent to the hospital. The vertex was presenting, with the head floating and the fetal heart tones audible in the right lower quadrant. The cervix was small, flattened and far posteriorly. A soft pulsating mass was found in the right lower quadrant and led to the suspicion of placenta previa or cystic ovary. Soft tissue x-ray studies were considered unsatisfactory; no soft parts could be determined and the uterine outlines were absent. The bladder was injected with 40 cc. of 12.5 per cent of aqueous solution of sodium iodide and a cystogram was made. The distance between the fetal head and the shadow of the bladder was about 8 cm. This was too great for placenta previa and abdominal pregnancy was a greater possibility. (Fig. 36.) Laparotomy was therefore elected.

Laboratory findings were: Hemoglobin 66 per cent; red blood cells 3,430,000; white blood cells 4,400. Urinary findings were essentially negative. Blood pressure (on absolute bedrest) ran as high as 180/100; lowest reading, 150/100.

The patient was operated upon February 27, 1943. When the abdomen was opened, a smooth, dark mass was found in the right lower quadrant. Above and to the right was the adherent omentum which overlay the shiny membranes enveloping the fetus. Above and to the left and occupying most of the sacral area was the uterus enlarged by fibroids to the size of a four and one-half months' pregnancy. The omentum was dissected away from the sac. The membranes were then ruptured and a living female child extracted. The placenta not only occupied the right adnexal area and the right wall of the pelvis but also seemed to have burrowed into the broad ligament; it could not be removed at this stage. Since the uterus was studded with numerous fibroids, it was decided to perform a high amputation from the left toward the right. The placenta was then peeled off the right wall of the pelvis. (Figs. 37 and 38.) Microscopic study

FIG. 43. Case IX, baby C. J., age fifteen months.

showed that the wall of the sac contained ovarian and tubal tissue.

The baby had bilateral calcaneus valgus and congenital dislocation of the hips as well as shriveled skin. (Figs. 39 and 40.) Ossification centers of the distal epiphyses of the femora were observed on a roentgenogram, indicating that the baby was at term. (Fig. 41.) Ossification centers of the proximal epiphyses of the tibiae were observed. Normally these appear at the end of the fortieth week or beginning of the forty-first week. There were two ossification centers in the os cuboidcum and in the rudimentary upper molars.

At thirteen and fifteen months of age the child showed normal intellectual development. The skin had assumed a normal texture and the congenital deformities of the lower extremities were respond-

FIG. 44. Case IX, baby C. J., age three years, three months. This child had congenital dislocation of right hip, with inadequate development of acetabulum. Open reduction was performed at age of eighteen months. Bilateral pes valgus was corrected previously.

ing to the care of the orthopedic staff (Dr. Joseph G. Wishner and Dr. Leo L. Roth). (Figs. 42 and 43.) At the age of three years and three months the child was well developed mentally and physically. (Fig. 44.) Her intellectual and physical development has continued normally to date.

SUMMARY

This study is based on a comprehensive review of the literature and on data obtained from 173 patients with histologically verified ectopic gestation treated surgically in the Sydenham Hospital during the fourteen-year period of 1934 to 1947.

The varieties of ectopic gestation listed in the order of their frequency were as follows: isthmial, ampullary, in the entire tube, at the fimbriated extremity, interstitial, cornual, tubo-ovarian, secondary abdominal and in a rudimentary horn.

Historical milestones are discussed in their chronologic order. Comparative anatomy is discussed briefly. Discussion of the following topics is based on data obtained from this series and on the experience of other writers

as recorded in the literature: incidence, etiology, symptoms and physical findings, diagnostic aids, differential diagnosis, pathologic anatomy, recurrent ectopic gestation, treatment, concomitant surgery, morbidity and mortality.

Five fatal cases are discussed in detail. Detailed reports of nine cases are presented and illustrated. In the illustrations an attempt was made whenever possible to determine the age of the fetus from the ossification centers. This method is often very helpful, especially in the numerous instances in which the pregnant woman cannot remember the exact time of her last normal menstruation. The illustrations also show the changes in the fetal skeleton which signify fetal death.

CONCLUSIONS

The earliest reference to ectopic gestation appears in the Talmud. True ectopic gestation is much less frequently encountered in animals than in humans. In this series ectopic gestation occurred in one of every sixty-nine obstetric admissions; in one of every forty-four gynecologic admissions and in one of every 113 combined obstetric and gynecologic admissions.

Fifty-eight patients (34 per cent) ranged in age from twenty-six to thirty years. One hundred sixty-four cases (95 per cent) occurred in the third and fourth decades of life. Sixty-five patients (37.6 per cent) were nulliparae; 108 (62.4 per cent) had been pregnant from one to eight times. Fifty-five women (31.8 per cent) gave a definite history of previous abortion.

Salpingitis was a cardinal etiologic factor in this series. Of the 129 patients studied histologically sixty-eight (52.7 per cent) showed positive evidence of salpingitis. Thirty-six patients (20.8 per cent) experienced relative sterility ranging from three to seventeen years. Thirty-four patients (19.6 per cent) had had previous abdominal or pelvic operations.

The symptom-complex in typical ectopic gestation makes immediate diagnosis possible; the atypical case may require employment of diagnostic aids.

Amenorrhea was experienced by 126 patients (73 per cent); abdominal pain was present in 153 cases (88.4 per cent); vaginal staining or bleeding was reported by 126 patients (73 per cent); nausea and vomiting occurred in fifty-six cases (32 per cent); faint-

ness and weakness were reported by eighty-one patients (47 per cent); shock was present in sixteen cases (9.2 per cent); definite urinary disturbances were reported by eleven patients (6.3 per cent); abdominal tenderness and rigidity were observed in eighty-three cases (48 per cent); an abdominal mass was palpated in thirteen patients (7.5 per cent); Cullen's sign was not observed in this series; a fluid wave was elicited in four patients; marked tenderness of the cervix on motion was noted in fifty-one patients (29.5 per cent); the uterus could be mapped out in only thirty-six patients, severe pain or extreme obesity precluded satisfactory palpation in the other cases; pelvic masses were palpable in eighty-nine patients (51.4 per cent); seventeen patients passed decidual casts.

Temperatures were high in cases of pelvic infection and subnormal in cases of abdominal hemorrhage. The highest temperature was 101.6°F.; the lowest, 95°F. The highest pulse rate was 140; the lowest, 68. The highest blood pressure reading was 220/170; the lowest, 40/0.

In cases of intact ectopic gestation or slow leakage the leukocyte count ranged from 5,000 to 10,000; in cases of recent but not massive hemorrhage the count was about 15,000; when hemorrhage was recent and massive, the count ranged from 15,000 to 30,000. The highest red blood count was 6,500,000; the lowest, 1,170,-000. The sedimentation rate in this series ranged from 5 mm. to 30 mm. The Aschheim-Zondek test or its modifications may be of value in atypical cases of questionable pre-operative diagnosis. In this series the Friedman modification of the Aschheim-Zondek test was done in fifty-three cases (39.6 per cent). In forty-three patients (24.9 per cent) the test was positive; in eight (4.6 per cent) it was negative and in two cases (1.1 per cent) the rabbit died.

Puncture and aspiration of Douglas' pouch is a relatively simple procedure for determining intraperitoneal bleeding. Posterior colpotomy is only of occasional diagnostic assistance; uterine curettement has limited value in this condition. Peritoneoscopy can be of diagnostic value in the hands of physicians who possess special experience with its use. Hysterosalpingography is helpful in diagnosing ectopic gestation, but care should be exercised lest a normal intra-uterine pregnancy

be disturbed. In this series of 173 patients, 159 (91.9 per cent) were correctly diagnosed preoperatively. Appendicitis, twisted ovarian cyst and incomplete intra-uterine abortion were the leading causes of preoperative diagnostic error in this series.

The nidation site of the ovum was indicated in 159 of the 173 cases (91.9 per cent). Fifty-seven ova (35.8 per cent) embedded in the isthmus of the tube; fifty-one (32.08 per cent) in its ampulla. The tubal pregnancy occurred on the right side in ninety cases (52 per cent), on the left side in seventy-three cases (42.2 per cent) and was bilateral in one case (0.6 per cent). In nine cases (5.2 per cent) secondary implantation occurred in the abdominal cavity. Many cases of hematosalpinx are undiagnosed ectopic pregnancies. Primary abdominal gestation is likely to occur more often in cases of endometriosis. Twin ectopic pregnancies are infrequent.

Included in this series is a case of lithopedion associated with a normal intra-uterine pregnancy and ruptured extra-uterine gestation.

There were three recurrent ectopic pregnancies in this series (1.7 per cent). Prompt surgical interference should follow the diagnosis of early ectopic gestation. In this series cyclopropane anesthesia was used with marked success.

Whole blood, plasma and solutions of salt and glucose are indispensable concomitants in the treatment of ectopic gestation. One hundred twenty-seven patients (73.4 per cent) received either transfusion or intravenous infusion during or after the operation. Before the abdomen is opened, a needle should be introduced into the vein to keep it patent, but active infusion should be deferred until the abdomen is opened and the bleeding vessels are clamped. The larger blood clots should be removed; free blood in the abdominal cavity may be left *in situ*. The tube *in toto*, including its interstitial portion, should be excised. However, if the woman is childless and the other tube has been removed, as much as possible of the proximal portion should be saved. The author prefers the abdominal route to vaginal section. The treatment for interstitial pregnancy is cornual resection, but supravaginal hysterectomy is at times a wiser procedure.

Pelvic hematocele should be treated surgically—by laparotomy if blood is present,

by eolpotomy if pus is found. Early abdominal pregnaney should be terminated by prompt laparotomy. The treatment of advaneed abdominal pregnaney presents major problems in the management of sae, adhesions, plaeenta and in eontrol of hemorrhage. The ineision should be elosed without drainage.

The treatment for ovarian pregnaney is ovariotomy. Whenever possible, operation should be limited to the minimum proeedure essential for treatment of the eetopie gestation.

In this series eoneomitant surgieal proeedures were performed on thirty-five patients (20.2 per eent). In four of these patients the postoperative eourse was stormy. Seventeen patients (9.8 per eent) of the entire series had postoperative eomplieations. In this series there were five deaths, a mortality rate of 2.9 per eent. There was one death (11.1 per eent) in the nine patients with seeondary abdominal pregnaney in this series.

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ARTERIAL VARICES

A SYNDROME

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THE purpose of this paper is to call to the attention of surgeons a group of patients who have arteriovenous anastomosis but who are diagnosed and treated erroneously for varicose veins. Due to inaccurate diagnosis the treatment is inadequate and often delayed; these patients have not been previously classified together.

These patients have arteriovenous connections of a congenital type, the junctions being closed for many years and suddenly opening with rapid enlargement of the veins which appears not unlike an acute varicose vein condition. This is not the simple aneurysmal varix in which one small branch of the arterial system dilates the saphenous tree but it is a congenital anastomosis of multiple small arteries with the saphenous system. Through years of experience operating on these patients in the Vascular Clinic we had become aware that in those patients referred for advanced varicose vein disease a high percentage had more vascular disorders than those with incompetent venous valves associated with ordinary varicose veins. The patients who had a prompt recurrence after the classical varicose vein operation were examples. The rapidity with which the recurrence followed these operations made it certain that there was some other pathologic process beside incompetent valves which needed correction.[1] Gradually we began to understand this pathology and now we are able to assemble criteria for correct diagnosis of these lesions.

The patient may or may not have a family history of enlarged veins. Usually there have been no vein dilatations present before. The usual history of the patient is that with some physical change in his life status, such as puberty or work requiring extra physical stress and strain or in a few at the time of atrophy of the musculature, the veins have appeared and quickly dilated. During the recent war many of these patients were seen. The strain of increased use of the limbs or the carrying of heavy packs precipitated the opening of insecurely closed arteriovenous connections. Wright also observed this incidence during the war years.[2-3] The patient states that these veins appear suddenly on the lateral or less often the posterior aspect of the leg rather than at the classical site on the medial aspect of the limbs.

PATHOGENESIS

The arterial and venous systems communicate during fetal life. These junctions normally close prior to birth. In some this closure does not occur at all, leading to congenital arteriovenous aneurysms, hemangiomas and other inherent vascular anomalies. In others the closure may be of a very inadequate nature, at times only a single layer of cells separating the arterial and venous systems. This is sufficient closure for a time but with increased intravascular pressure due to growth, unusual strain or trauma, immature connections "blow out." With the opening of these multiple connections, arterial blood is pumped into the larger veins. These superficial veins and their branches dilate rapidly and with the increased arterial pressure a rich collateral venous circulation develops. The femoral artery or one of its branches are the usual arterial source and the saphenous system is the venous end of this connection. In others, multiple anastomosis between the popliteal artery

and the lesser saphenous system are found. In either case there are usually many secondary arteriovenous connections on the lateral side of the thigh or calf.

SYMPTOMS

The patient usually will state that varicose veins suddenly developed in his legs which had been normal before. Sometimes the first sign noticed is an increased local heat at the site of the vein which is registerable with the hand and always with a potentiometer. There is a heaviness and some cyanosis in the part. When the limb is elevated, the veins empty incompletely but never as rapidly as do the varicose veins associated with incompotent valves. The dilated vessels can be reduced with finger pressure, but when the pressure is removed the vessels fill very rapidly. The veins appear to be of a lighter color and should they rupture the blood is the color of arterial blood. Very rarely a thrill and bruit may be present but usually they are not. A bruit is caused by the whirling of arterial blood in an enlarged vein or in a sac. If the vein or sac is large enough and the arterial connections small or multiple, the vein may be able to take up the arterial blood without the whirling which causes the thrill and the bruit. If the needle on a syringe of saline or sclerosing solution is introduced into one of these vessels, arterial blood *will* be seen entering the fluid in the syringe barrel with each heart beat. At operation multiple small arteries are seen entering the saphenous system at the femoral bulb or at the popliteal space. When these are observed carefully, it will be noted that they are pulsating synchronously with systole of the heart. At times the operative trauma may throw the vessel into spasm but if sufficient time is allowed to permit this spasm to relax the arterial pulsation will be seen. When these apparent veins are opened, bright red, arterial blood will be present. The number of branches may vary from a few to more than one hundred and these are in the groin or in the popliteal space. Multiple,

small, secondary arteriovenous connections are present, particularly on the lateral aspect of the leg. These secondary connections are thin-walled and their excision is extremely difficult due to the immature nature of their walls. (Fig. 1.)

PATHOLOGY

The pathologic criteria for diagnosis of this syndrome are nearly complete. Pathologists require certain wall characteristics to be present in order to diagnose a vessel as either an artery or vein. In this syndrome, however, the vessel walls are not fully developed. In this respect they resemble new growth. Most of the vessels on section show a wall which has more coats than a vein but not all of those seen in an artery. This increased thickness in the vessel wall over that of a vein is the response of the vessel to the trauma of the arterial pulsation. The actual pathologic point at which the arteriovenous connection occurs may not be ascertainable on section. Additional pathologic data will be assembled as time goes on. Oxygen saturation tests will show a much higher percentage in these than in other veins. (Fig. 2.)

DIAGNOSIS

The diagnosis can be made by watching for the following points: The veins appear suddenly and dilate rapidly. These enlarged vessels occur most often on the lateral aspect of the leg or in the popliteal space. The veins remain partially filled on elevation of the limbs. The blood in these vessels can be reduced on pressure but the veins fill more rapidly than ordinary varicose veins on a valve failure basis. When such vessels are opened, arterial bleeding is present; this pulsation is synchronous with cardiac systole. If a needle is introduced into these veins, arterial blood will be found pulsating in the syringe barrel. There is an increased skin surface temperature at the point of connections and this usually is registerable with the hand and always with a potentiometer. There may be a bruit present but usually there is not. Oxy-
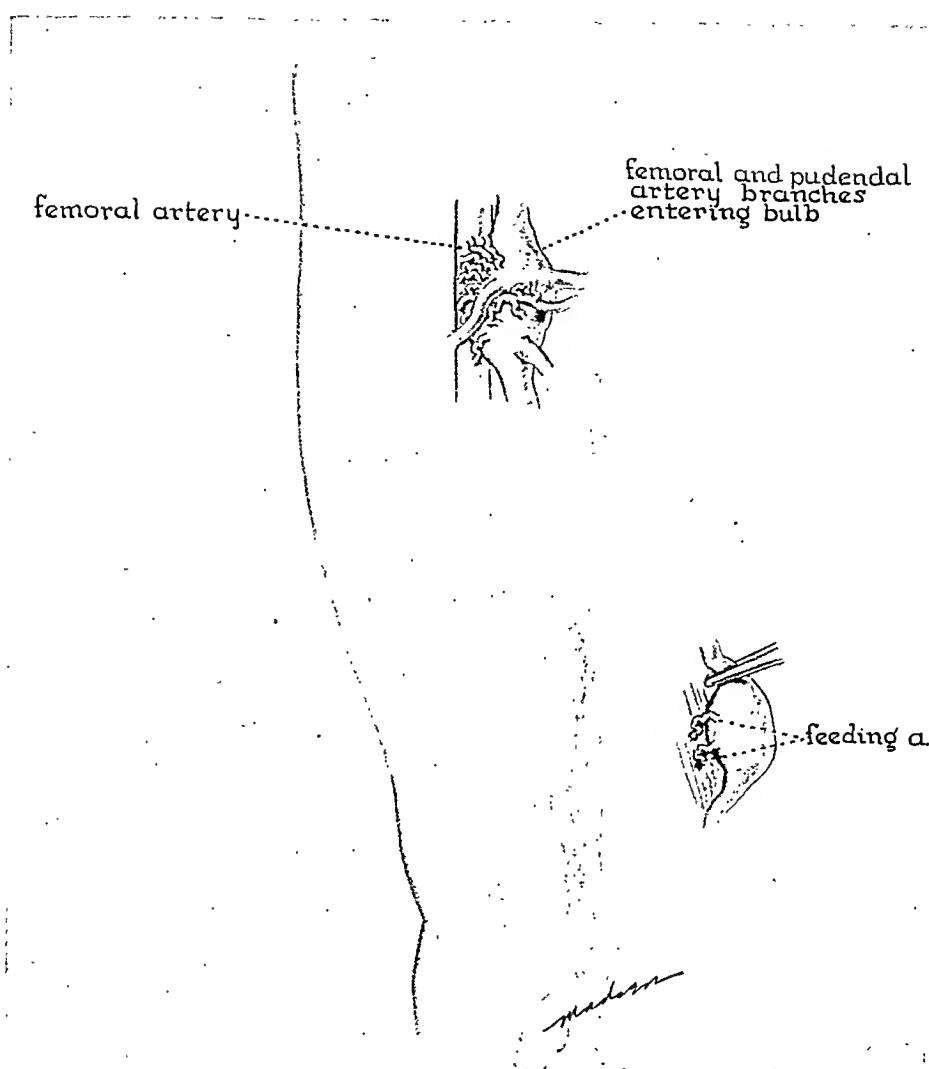
FIG. 1. Drawing showing the multiple arterial connections in this instance from the femoral vein into the saphenous system. Insert shows an incompetent point with two small feeding arteries. Surgical correction includes excision of these points and ligation of the arteries.

gen saturation tests carried out on the blood of these vessels will show a much higher percentage of saturation than in other veins in the same patient's body. In one instance oxygen saturation was compatible with arterial blood. At operation time multiple small arterial connections to these enlarged veins can be seen. These lesions have been diagnosed as varicose veins and in many cases have been operated upon; following operation, the veins recurred promptly. Re-operation in such instances will show the original pathologic disorder. (Fig. 3.)

We have analyzed the last 272 patients sent to us with a diagnosis of varicose veins of an advanced nature. Of these, sixty-five (24 per cent) were found to have arteriovenous connections of the type described. In this same group of 272 were sixty-one patients who had been operated upon before, with prompt recurrence of the varicosities. In this recurrent group approximately 50 per cent of the patients had these arterial connections. The other recurrences occurred because of incomplete surgery in the groin or at the incompetent points or because new incompetent points developed. Thus one-half of those patients who had recurrences after apparently ade-

FIG. 2. Pathologic cross section; the wall is much thicker than that of the normal vein but the typical coats seen in an artery are missing. Vessel wall proliferation is secondary to trauma of the arterial blood, × 50.

quate surgery had this arterial venous syndrome which had not been correctly diagnosed or treated before.

TREATMENT

The treatment for arterial varicies is as follows: (1) The saphenous vein and its branches should be exposed in the groin and all connections from the arterial or venous side dissected free and widely excised. A 4 inch section of the saphenous vein should then be removed, the proximal end being divided at the femoral junction. Any other abnormal connections between the artery and vein should be divided. (2) Each of the incompetent venous communicating points as shown by the test we have described before[4] should be widely excised and any secondary arterial connections likewise divided. (3) The large veins on the lateral aspect of the leg or in the popliteal space must be widely excised *en masse*, all small connections being divided and ligated. This procedure may have to be repeated because of the tendency of these vessels to recur. (4) At six-month intervals for a

FIG. 3. Tremendously dilated veins typically seen in arterial varices. In other instances vessels may be localized laterally or posteriorly.

period of several years thereafter these patients must be examined. If there is any evidence of increasingly dilated veins or increased local heat, these areas should be treated secondarily. If these areas are large, resection is required. If the recurrent connections are small and of an immature nature, a sclerosing solution injection may obliterate them. (5) The prognosis for recurrence should be explained to the patient and his family and differentiation of this group from ordinary varicose veins made clear.

SUMMARY

1. This syndrome, to our knowledge, has not been emphasized before.

2. These arterial venous connections are usually misdiagnosed as varicose veins. These connections occur much more com-

monly than is supposed. In our practice 24 per cent of the patients we see with advanced varicosities have this syndrome. The syndrome can be diagnosed by the various features already discussed.

3. Accurate diagnosis of this syndrome is required in order to perform the necessary surgical treatment. This is also important from the prognostic standpoint.

4. The condition should be suspected if the veins appear rapidly on the lateral or posterior portions of the legs, if the patient is relatively young, if there is increased local heat and if the veins recur after previous competent vein surgery.

5. Adequate and at times repeated surgery will control the condition.

6. The tendency of these arterial varices to recur seems inherent. With the immaturity of the blood vessels and their local spread and difficulty of eradication, the condition simulates new growth.

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L. J. KLEINSASSER finds peripheral arteriography to be very helpful in visualizing aneurysms, fistulas, early bone malignancies, site of an arterial embolus and in valuation of collateral circulation, etc. He, therefore, concludes that it is very valuable in the diagnosis and even in the therapy of many arterial lesions. This procedure should become familiar to all active general surgeons, even those who do not care to undertake the treatment of vascular lesions. (*Richard A. Leonardo, M.D.*)

SIGNIFICANCE OF DIETARY SUPPLEMENTATION IN SURGICAL CASES*

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THIS clinical study of sixty-six representative surgical cases had as its aim the determination of the value and practicability of incorporating a specially formulated dietary supplement in the preoperative and postoperative feeding program of the "average" surgical patient.

RATIONALE OF DIETARY SUPPLEMENTATION

It is now universally recognized that nutritional status is a vital factor—in fact the outstanding single factor influencing the capacity of the patient to withstand the effects of anesthesia and surgical trauma and to recover normal strength and health promptly after operation. Most prospective surgical patients, however, are nutritionally depleted.[1-6] Their intake of nutrients may have been limited by anorexia, weakness, pain, nausea, vomiting or gastrointestinal conditions. The individual's diet may have been inadequate in varying degrees for years. Digestion and absorption may have been deranged during a prolonged period. In other cases metabolic utilization of various factors may have been faulty or the requirements for certain nutrients, such as protein, certain vitamins, calcium and iron, may have been greatly increased as in febrile conditions, hyperthyroidism and many other disease states.

Not infrequently the effects of an accumulated nitrogen deficit may be exacerbated by protein losses from hemorrhage or into draining wounds, sinuses, traumatized tissues and areas of inflammation.

Important in every field of medicine, adequate protein intake is of special concern to the surgeon.[1,7,8] As stressed by Ravdin and Zintel,[2] "Probably the most common dietary deficiency is a deficiency of protein. Such a deficiency is especially serious in surgical patients because proteins are the building blocks for the repair of damaged tissues. In addition, they provide the necessary amino acids for antigens, hormones, and enzymes. . . . Protein is concerned in the transportation of lipids in the body. . . . Hypoproteinemia predisposes to poor wound healing, wound dehiscence, failure of fractures to unite, anemia, visceral edema with its resultant embarrassment of the lungs and gastrointestinal tract, and to a reduced resistance to generalized infections." Moreover, protein has a distinctly positive, direct effect in protecting the liver against toxic side effects of anesthetics and many drugs; a high protein diet conditions the liver for minimal injury.[9] Finally, it is of the utmost significance that in the "reaction of injury" associated with surgical manipulation, protein catabolism is increased and therefore the requirement for protein is increased.[3] Inevitable postoperative losses of protein must be anticipated nutritionally. It is easier and safer to forestall hypoproteinemia than to make restitution for it.

Most of the nutritional deficiencies in the surgically ill patient prior to the institution of therapy are complex and involve several dietary components.[2,4] Subclinical deficiencies of the B vitamins (especially thiamin, riboflavin and niacin) and vitamin C are encountered with the highest frequency.[2,10] Disturbance of the physiologic processes may be profound and serious long before the gross pathologic changes or clinical pictures of avitaminosis become evident. Concerning the role of vitamins in protein synthesis in the tissues,[11] Cannon[1] has recently stated: "There can no longer

be any doubt about their essentiality or that they are as mutually indispensable as are the amino acids and calories," further, with particular reference to the surgical patient, "an ample supply of vitamins, . . . especially of the B complex, must be insured." Both liver function and thyroid activity are directly involved in vitamin A metabolism[12] and the requirements for vitamin A (as distinguished from its carotene precursors) may be markedly elevated in many surgical conditions.[2] Adequate vitamin C is essential in normal healing of wounds, osteogenesis and prevention of anemia.

Two minerals, calcium and iron, also have decided significance in nutrition of the surgical patient. As noted by Wilder[13] calcium and iron "are used as supplements to therapeutic diets with advantage." Because approximately one-half of the serum calcium is bound to the serum protein, hypocalcemia is associated with hypoproteinemia. Calcium and vitamin D are involved in bone healing. Iron, of course, is indispensable in hematopoiesis and, as a component of enzyme systems, in tissue synthesis.

Thus a review of the literature indicates that in the nutrition of the average surgical patient the diet not only must compensate for probable deficiencies in protein, certain vitamins, calcium and iron but also must provide for replenishment of the body reserves of nutritive factors in anticipation of increased requirements and in preparation for surgical interruption of normal alimentation.

In surgical cases the protein requirements are generally higher than the usual $1\frac{1}{4}$ to $1\frac{1}{2}$ Gm. per kg. (60 to 120 Gm. of protein) per day recommended for adults. The use of "prophylactic doses" of vitamins is now an established routine in the management of the surgical patient, high levels of the following vitamins in particular being recommended: vitamin A, thiamin, riboflavin, niacin, other members of the B complex as supplied by brewer's yeast, vitamin C, and vitamin D (Ravdin and Zintel).[2] Calcium and iron should also

be supplied at levels substantially above those regarded as adequate for the normal, healthy adult. In addition, the diet must be low in fat but moderately high in carbohydrate so as to provide some 2,500 calories or more daily. It must be highly digestible, well tolerated and readily assimilated. Its bulk must not be excessive, i.e., the limited capacity of the debilitated patient to ingest foodstuffs must be taken into practical account.

Finally, for efficient metabolic utilization of the various nutritive factors they should be *simultaneously* available to the tissues.[1,14-17] As stated emphatically by Rose[14] and more recently reiterated by Cannon:[1]

"If a tissue is to be formed at all, every component required must be available or be capable of being manufactured by the cells; otherwise the synthesis will not occur."[14]

Thus not only the diet as a whole but each meal should be well proportioned with respect to the overall content of the essential dietary factors all being needed at the same time for most efficient tissue fabrication. Missing factors are limiting factors hindering optimal utilization of the diet. It would appear highly probable that some synergism is involved.

Analysis of the foregoing nutritional considerations, together with practical problems of judiciously supplying all dietary essentials simultaneously, indicated the probability that a specially formulated dietary supplement could be advantageously employed to satisfy the multiple requirements in the average surgical patient. Preoperative and postoperative administration of the special supplement has demonstrated its value in building up the patient's general condition, in anticipating the drain on the body stores of protein, vitamins and minerals at the time of operation and in promoting recovery after surgery.

COMPOSITION OF THE DIETARY SUPPLEMENT

The dietary supplement employed in this study was a spray-dried mixture of whole

milk, skim milk, dried brewer's yeast forti-
fied with riboflavin concentrate, vitamins
A and D concentrate from fish liver oils,
irradiated ergosterol, ascorbic acid, nia-
cinamide, monosodium phosphate and iron
citrate. The milk ingredients were so

TABLE I

	Gerilac (powder) (per cent)	Eleven Level Tablespoons (82 Gm.) and 1 Pint Water (per cent)
Milk fat................	10	1 5
Milk proteins..........	33	5.0
Milk sugar (lactose)........	47	7.0
Minerals................	7.5	1 0
Water..................	2.5	85.5
Calories—4.1 per Gm......	116 per ounce, 300 per pint.	

Pint Standard Dilution

Protein......	26 Gm.	
Calcium...............	830 mg. 110 per cent*	
Phosphorus....	800 mg. 105 per cent	
Iron...................	16 mg. 160 per cent	
Vitamin A.............	6500 USP units 160 per cent	
Vitamin B₁......	2.2 mg. 220 per cent*	
Vitamin B₂.....	2.7 mg. 130 per cent	
Niacinamide..........	18 mg.†	
Vitamin C.............	85 mg. 280 per cent	
Vitamin D.............	700 USP units 175 per cent	

* Per cent minimum daily adult requirements.
† Minimum daily requirements not established.

formulated to provide high protein and low
fat content. It was designed to supply in
one reliquefied pint the full dietary allow-
ances of vitamins and minerals and more
than one-third of the protein recommended
by the Food and Nutrition Board, National
Research Council for moderately active
men and women. The percentage composi-
tion and the content of vitamins and
minerals are shown in Table I.

CLINICAL MATERIAL

Sixty-six cases, including nine employed
as controls, were studied in this investiga-
tion. Eleven of the patients were male and
the remainder were female. The youngest
patient was fifteen years of age and the
oldest was eighty-six. (Table II.)

This group represented a variety of sur-
gical conditions. Among the different
types of operations performed were radi-

TABLE II

Case No.	Age	Sex	Type of Operation Performed
1	56	F	Procidentia
2	52	F	Radical mastectomy
3	30	F	Cauterization of cervix
4	26	F	Thyroidectomy
5	51	F	Panhysterectomy; herniotomy
6	61	F	Thyroidectomy
7	19	F	Thyroidectomy
8	25	F	Herniotomy
9	51	F	Thyroidectomy
10	50	F	Hysterectomy
11	29	F	Thyroidectomy
12	39	F	Panhysterectomy
13	25	F	Laparotomy
14	44	F	Thyroidectomy
15	74	F	Thyroidectomy
16	39	F	Thyroidectomy
17	41	F	Hysterectomy
18	50	F	Hysterectomy
19	25	F	Appendectomy
20	49	F	Panhysterectomy
21	44	F	Hysterectomy
22	48	F	Cauterization of cervix
23	46	F	Mastectomy
24	48	F	Colostomy
25	33	F	Hysterectomy
26	63	F	Thyroidectomy
27	43	F	Hysterectomy
28	29	F	Thyroidectomy
29	15	F	Thyroidectomy
30	51	M	Colostomy
31	24	F	Laparotomy
32	40	F	Thyroidectomy
33	43	F	Thyroidectomy
34	48	F	Vaginal plastic and hemorrhoidectomy
35	38	M	Gastric resection
36	51	M	Cholecystectomy
37	65	F	Thyroidectomy
38	86	F	Herniotomy
39	82	F	Mastectomy
40	32	M	Pilonidal sinus
41	25	F	Hemorrhoidectomy
42	64	M	Thyroidectomy
43	38	F	Hysterectomy
44	67	M	Gastro-enterostomy
45	59	M	Gastro-enterostomy
46	58	M	Laryngectomy
47	57	F	Mastectomy
48	39	F	Thyroidectomy
49	41	F	Cholecystectomy
50	58	F	Thyroidectomy
51	27	F	Laparotomy
52	75	M	Prostatectomy
53	41	F	Cholecystectomy
54	55	F	Thyroidectomy
55	59	F	Gastrectomy
56	66	M	Gastrectomy
57	59	M	Herniotomy

cal mastectomy, hysterectomy, appendectomy, thyroidectomy, herniotomy, laparotomy, colostomy, hemorrhoidectomy and cholecystectomy.

The patients employed as controls were selected in the following manner: In the instances in which the clinical course of a patient was to be compared with that of a control both were of the same sex and approximately the same age and underwent the same type of operation on the same day. Insofar as could be ascertained at the time of institution of therapy the general clinical pictures in the two patients were approximately the same.

PROCEDURE

In all sixty-six cases the patients received a diet that was well balanced, well tolerated and apparently well assimilated. Moreover, with respect to the recognized nutritional requirements of the normal, healthy adult, this diet was "adequate."

In addition fifty-seven patients received the dietary supplement* which provided higher levels of biologically superior protein, vitamins and minerals. The diet of the controls was not supplemented in this fashion. The periods during which the dietary supplement was given ranged from two weeks to three months. In fifteen cases the dietary supplement was administered daily during the preoperative period; of these patients thirteen received the supplement for two weeks, one patient for three weeks and one for seven weeks preoperatively. In thirteen of these fifteen cases the patient was also given the dietary supplement for two or three weeks postoperatively.

In forty-two instances the dietary supplement was administered postoperatively (but not preoperatively), beginning in most cases three or four days after operation; dietary supplementation was continued for various lengths of time in different cases (two weeks to three months). In ten cases dietary supplementation was begun

* Two 8 ounce glasses (one reliquefied pint) of gerilac daily.

several weeks after operation because of the unfavorable clinical condition and slow convalescence of the patient.

All patients were carefully studied. Blood determinations included hemoglobin value, red cell count, differential white blood cell picture and blood calcium. Reaction to anesthesia, operation and chemotherapy was noted as well as the general clinical course and rate of convalescence as evidenced by wound healing, gain in weight and strength and subjective improvement. (Fig. 1.)

Clinical Observations. In all of the fifty-seven patients receiving the dietary supplement the clinical course was gratifyingly smooth and convalescence was comparatively rapid, i.e., more rapid than in the control patients. Adverse effects of anesthesia, surgical manipulation and chemotherapy were minimal. In the instances in which it was possible to give the dietary supplement for two weeks before operation the patients showed gains in appetite, weight and strength, experiencing at the same time a sense of improved well being.

Administered postoperatively the dietary supplement aided in reducing the patient's discomfort and in promoting satisfactory convalescence. The progress of the controls was definitely less satisfactory and recovery was slower. In the instances in which the dietary supplementation was instituted some weeks after operation (because of the unfavorable clinical condition and slow convalescence of the patient) the patient showed decided improvement and convalescence became quite satisfactory as the nutritional status was ameliorated.

Blood determinations reflected the favorable clinical results associated with routine provision of a diet high in biologically potent protein, with unusually high levels of vitamins and minerals. In almost every instance in which the hemoglobin value was low it showed a marked rise as dietary supplementation was continued. Red blood cell counts indicative of mild anemia were also increased practically without exception. At the same time the white blood cell

picture manifested a tendency to return to normal. In cases in which the blood calcium was subnormal it generally showed a rise to within the normal range.

There were no signs or symptoms of liver damage occasioned by any possible hepato-toxic agents. Edema was not encountered and in every instance wound healing was satisfactory. The gains in weight were taken to be the most impressive evidence of efficient tissue fabrication resulting from a constantly favorable nutritional status.
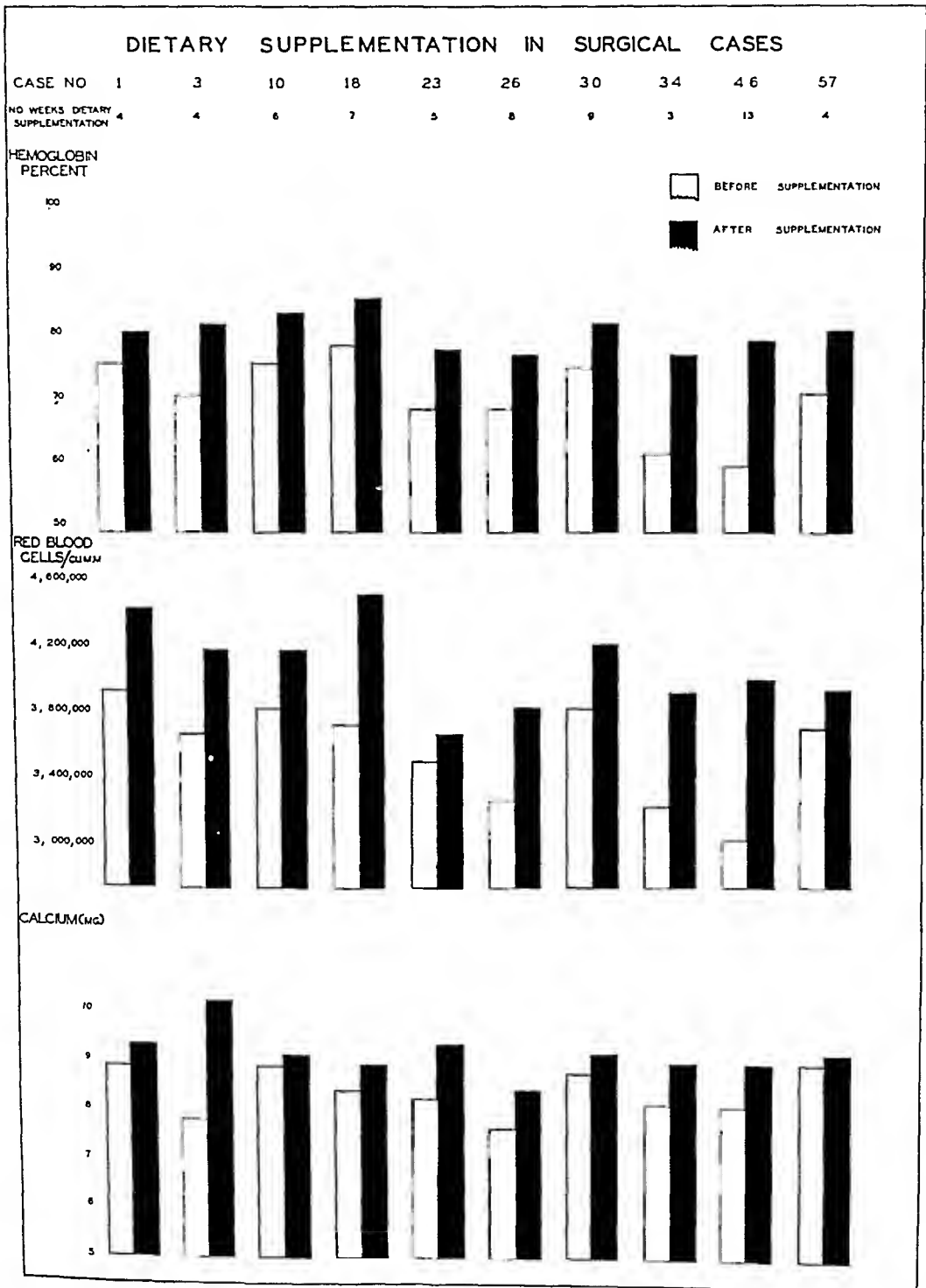

FIG. I.

The dietary supplement was found to be quite acceptable with respect to palatability, digestibility, ease of preparation and administration and economy.

Table III shows typical increases in

TABLE III

Case No.	No. Weeks Dietary Supplement Received	Hemoglobin %		Red Blood Cells Cells		Blood Calcium	
		Before	After	Before	After	Before	After
1	4	75	80	3,920,000	4,420,000	8.9	9.3
2	8	70	81	3,460,000	4,420,000	8.7	10.3
3	4	70	81	3,650,000	4,170,000	7.8	10.2
4	3	86	92	4,480,000	4,680,000	9.0	10.1
5	4	87	89	4,420,000	4,610,000	10.6	10.1
6	4	79	83	4,010,000	4,470,000	9.1	9.0
7	4	80	85	4,020,000	4,310,000	9.2	9.2
8	5	72	80	3,710,000	4,130,000	9.2	9.4
9	2	85	87	4,210,000	4,370,000	9.1	9.8
10	6	75	83	3,810,000	4,170,000	8.9	9.1
11	4	78	86	3,910,000	4,410,000	8.6	9.1
12	4	80	85	4,010,000	4,390,000	9.0	9.2
13	6	80	87	4,070,000	4,390,000	10.1	
14	4	81	83	4,100,000	4,130,000	9.2	9.4
15	3	81	86	4,050,000	4,270,000	10.7	10.7
16	2	79	81	3,960,000	4,090,000	10.8	
17	4	78	83	3,910,000	4,290,000	9.4	
18	7	78	85	3,710,000	4,510,000	8.4	8.9
19	4	75	77	3,700,000	3,920,000	8.4	9.2
20	2	80	82	4,000,000	4,190,000	9.1	9.6
21	6	80	86	3,810,000	4,120,000	9.2	
22	6	71	80	3,680,000	4,040,000	8.6	
23	5	68	77	3,480,000	3,650,000	8.2	9.3
24	4	80	84	3,700,000	4,290,000	8.4	8.8
25	5	75	80	3,900,000	4,170,000	9.2	
26	8	68	76	3,240,000	3,820,000	7.6	8.4
27	3	78	81	4,050,000	4,230,000	8.7	8.9
28	2	82	86	4,110,000	4,230,000	9.5	
29	Blood picture essentially normal						
30	9	74	81	3,810,000	4,200,000	8.7	9.1
31	3	80	82	4,020,000	4,170,000	9.2	
32	3	70	78	3,620,000	3,980,000	8.9	9.3
33	3	69	76	3,560,000	3,870,000	8.9	9.2
34	3	60	76	3,210,000	3,900,000	8.1	8.9
35	6	80	81	4,010,000	4,200,000	9.4	
36*	3	79	81	4,100,000	4,290,000	9.3	8.7
37	Blood picture essentially normal						
38	Blood picture essentially normal						
39	6	71	81	3,740,000	4,260,000	8.7	9.4
40	8	83	87	4,220,000	4,470,000	8.7	9.2
41	Blood picture essentially normal						
42	2	80	89	4,100,000	4,590,000	8.9	9.0
43	Blood picture essentially normal						
44	13	76	84	3,720,000	4,180,000	8.2	9.0
45	13	76	89	3,960,000	4,620,000	8.9	9.2
46	13	58	78	3,010,000	4,080,000	8.0	8.9
47	3	79	85	4,020,000	4,450,000	9.2	
48	Blood picture essentially normal						
49	13	79	83	3,980,000	4,210,000	9.0	9.3
50	9	83	85	4,140,000	4,290,000	9.2	
51	6	78	85	3,710,000	4,210,000	8.2	9.1
52	8	63	80	3,640,000	4,280,000	8.1	9.2
53	Blood picture essentially normal						
54	Blood picture essentially normal						
55	10	70	80	3,510,000	4,100,000	8.6	9.1
56	4	75	82	3,720,000	4,190,000	9.0	9.2
57	4	70	80	3,690,000	3,910,000	8.9	9.1

* Inoperable carcinoma (metastatic) of the liver which was secondary to the sigmoid. After recurrence of the carcinoma the condition of the patient became much more serious. Dietary supplementation continued because the patient stated that it made him feel better.

hemoglobin value, red cells per cu. mm. and blood calcium. Cases 1, 3, 10, 18, 23, 26, 30 and 57 may be regarded as representative of the results obtained in this study. Cases 34 and 46 are among those showing more striking improvement in the blood picture.

CASE REPORTS

CASE 4. M. G., a female aged twenty-five had a severe case of exophthalmic goiter. The patient received the dietary supplement, two 8 ounce glasses (standard dilution) daily, for three weeks prior to thyroidectomy. The patient noted decided subjective improvement associated with gains in appetite, weight and strength. Reaction to anesthesia and operation was minimal. Convalescence was unusually satisfactory and there was rapid recovery of strength and health. Comparable cases of those not given the dietary supplement had a less satisfactory clinical course. Before dietary supplementation the blood calcium was 9.0, afterward the value was 10.1. Simultaneously the hemoglobin value rose from 86 to 92 per cent and the red cell count increased from 4,480,000 to 4,680,000. The white blood cell picture also manifested a tendency to return to normal.

Because all other hyperthyroid patients have responded in a similarly gratifying manner to dietary supplementation, we believe that administration of the supplement is definitely indicated in such cases.

CASE 13. G. L., a female aged twenty-five underwent a laparotomy. Postoperatively and during convalescence for a period of six weeks this patient received the dietary supplement, two 8-ounce glasses daily. Subjective as well as clinical improvement was definitely more rapid and more satisfactory than in the control patient. During the period of dietary supplementation the hemoglobin value increased from 80 to 87 per cent, the red cells per cu. mm. increased from 4,070,000 to 4,390,000 and the improved white blood cell picture reflected the excellent clinical progress.

CASE 34. F. M., a female aged forty-eight had a vaginal plastic and hemorrhoidectomy performed. At the time when dietary supplementation was begun the patient was unusually debilitated. Her blood pressure was 100/70; blood calcium, 8.1; hemoglobin, 60 per cent

and red cells per cu. mm., 3,900,000. Subsequently convalescence was satisfactory.

CASE 40. E. C., a male aged thirty-two underwent an operation for pilonidal sinus. For two months after the operation the patient received the dietary supplement. As his nutritional status improved, he gained weight and strength. The white blood cell picture showed a marked trend toward normal; blood calcium increased from 8.7 to 9.2 mg.; the hemoglobin value rose from 83 to 87 per cent while the red cell count increased from 4,220,000 to 4,471,000.

COMMENTS

In the patients receiving a dietary supplement high in protein, moderately high in carbohydrate and low in fat, with vitamins and minerals at levels substantially above those usually recommended for the normal, healthy adult, the clinical course and convalescence were conspicuously more satisfactory than in the control patients who were not given the supplement. It is to be emphasized, moreover, that among the patients studied as controls in this investigation there were no distinct indications for specific dietotherapy, i.e., there were no clinical pictures characteristic of avitaminosis, protein depletion or mineral deficiency. Their diet was well balanced, well tolerated and apparently well assimilated and, in terms of the recognized requirements of the normal adult, "adequate." Nevertheless, the less satisfactory clinical course and slower convalescence of the controls may logically be presumed to represent results of an unfavorable nutritional status.

These findings are clearly in consonance with the conclusions reached by other investigators: (1) Practically every prospective surgical patient has undergone a steady depletion of the tissue reserves of protein, carbohydrate, fat, vitamins and minerals. (2) The diet of the average surgical patient must be especially supplemented with high quality protein, vitamins (especially those of the B complex and vitamin C), calcium and iron. It is also advisable to ensure adequate intakes of vitamins A and D. (3) The diet should be moderately high in carbohydrate as well as high in protein but low in fat. (4) For most efficient metabolic utilization of the essential nutritive factors any dietary supplement should be so constituted to permit practically simultaneous delivery of all factors to the tissues. Hence the supplement not only should incorporate all of the nutrients but should also provide them in easily digestible and readily absorbable form. (5) The closer the approximation to the optimal nutritional status the lower the surgical morbidity and mortality will be and the more rapid the convalescence. An adequate diet will reduce the discomfort and increase the sense of well being of the surgical patient.

SUMMARY

1. The value and practicability of the preoperative and postoperative administration of a special dietary supplement were studied in fifty-seven surgical patients. Nine other surgical patients were employed as controls.

2. The dietary supplement (gerilac)* is a spray-dried mixture of whole milk, skim milk, dried brewer's yeast fortified with riboflavin concentrate, vitamins A and D concentrate from fish liver oils, irradiated ergosterol, ascorbic acid, niacinamide, monosodium phosphate and iron citrate. The milk ingredients are so formulated as to provide a high protein and low fat content.

3. The periods during which the dietary supplement was administered ranged from two weeks to three months. In fifteen cases the dietary supplement was given daily during the preoperative period. In thirteen of these cases the patient was also given the supplement for two to three weeks postoperatively.

4. In forty-two instances the dietary supplement was administered postoperatively and during convalescence (but not preoperatively), beginning in most cases three or four days after operation.

5. All patients were carefully studied.

* Gerilac, manufactured by The Bordon Co., Prescription Products Division, New York, N. Y.

Blood determinations included hemoglobin value, red cell count, differential white blood cell picture and blood calcium. Reaction to anesthesia, operation and chemotherapy was noted as well as general clinical course and rate of convalescence as evidenced by wound healing, gain in weight and strength and subjective response.

6. In all of the fifty-seven patients receiving the dietary supplement the clinical course was gratifyingly smooth and convalescence was comparatively rapid, i.e., more rapid than in the control patients. Adverse effects of anesthesia, surgical manipulation and chemotherapy were minimal.

7. Patients receiving the dietary supplement preoperatively showed gains in appetite, weight and strength, experiencing at the same time a sense of improved well being.

8. Administered postoperatively and during convalescence the dietary supplement aided in reducing the patient's discomfort and in promoting rapid convalescence. The progress of the controls was definitely less satisfactory.

9. The blood determinations reflected the favorable clinical results associated with the routine provision of a diet high in biologically potent protein, with unusually high levels of vitamins and minerals. Hemoglobin values and red cell counts were increased as was the blood calcium in most cases in which it was subnormal. At the same time the white blood cell pictures showed marked trends toward normal.

10. The gains in weight associated with dietary supplementation were taken to be the most impressive evidence of efficient tissue fabrication resulting from a constantly favorable nutritional status.

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INFECTIONS OF THE HEAD AND NECK*

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ANALYSIS of results obtained with different types of therapy in 200 cases was undertaken to evaluate the different types of therapy we have used in 200 patients with head and neck infections who were admitted to the Plastic Surgery

TABLE I
PREDISPOSING FACTORS

	No. Cases	Per Cent
Skin	..	42.5
Eruptions such as furuncle, impetigo, etc.	42	21
Lacerations	26	13
Blunt trauma (fractured jaws, contusions, etc.)	17	8.5
Dental	..	37
Tooth extractions	35	17.5
Alveolar abscesses	25	12.5
Carious teeth	14	7
Upper respiratory tract infections	10	5
Parotitis	6	3
Other causes	5	2.5
Not determined	20	10

Service at Kings County Hospital from 1944 to 1946. We have attempted to compare the results obtained by use of aspiration and penicillin instillation in these infections with our previous methods of treatment. At the same time we were able to derive interesting statistical data that might be helpful to better understand head and neck infections.

Predisposing Factors. As can be seen in Table 1 most of the infections of the head and neck were secondary to infections of the cephalic skin and the oropharynx. Some workers have stressed the almost exclusive origin of these infections from dental disturbances. O'Brien and Rubin in 1942 presented 101 cases of head and neck infection from our own service after oral diseases had occurred. In 1944 Wald reported 100

cases and in 1945 Alden reported 200 cases of head and neck infection which were of dental origin.

The importance of skin infection, especially on or about the lips and the nose, has been an often considered subject. In 1912 Bullock discussed the dangers of a carbuncle of the lip and advised ligation of the facial vein as a prophylactic procedure to prevent cavernous sinus thrombosis. In 1928 Bailey described the surgical technic for ligation of the angular vein in cases of spreading infections of the upper lip and nose. In our series the skin became infected in 42.5 per cent of all the cases (one-half of these began with primarily or secondarily infected cutaneous eruptions); 13 per cent followed lacerations and 8.5 per cent followed blunt trauma. In 37 per cent of the cases we were able to obtain either a history of dental extraction or upon examination we found alveolar abscesses and/or carious teeth. We were not able to determine the primary dental condition necessitating extraction in patients admitted after dental extraction had taken place. We suspect that most of this group had preceding alveolar abscesses.

Upper respiratory tract infections and suppurative parotitis accounted for the remainder of the antecedent conditions. In 10 per cent of the cases the nature of the predisposing factor could not be determined after careful history, physical examination and laboratory studies.

BACTERIOLOGY

Eighty-three patients had suppuration. In thirty-five cases bacteriologic studies were available which are summarized in Table II. The most common bacteria found were staphylococci and streptococci. Three patients had mixed staphylococcus and

streptococcus infection. These findings are similar to other reports recorded in the literature by Bullock (1912), Blair and Padgett (1923), Herrell et al., (1942) Lyons (1945) and Gaines and Hatcher (1945).

TABLE II
BACTERIOLOGY

Organism	No. Cases
Staphylococcus............................	13
Staphylococcus aureus.....................	8
Staphylococcus aureus hemolyticus..........	5
Streptococcus.............................	7
Streptococcus hemolyticus.................	4
Streptococcus non-hemolyticus.............	2
Streptococcus viridans....................	1
Mixed staphylococcus and streptococcus........	3
Hemolytic streptococcus and staphylococcus aureus...................................	1
Streptococcus viridans and staphylococcus aureus	1
Streptococcus viridans and staphylococcus albus	1
Gram-positive organism (unidentified)..........	1
Diphtheroids...............................	1
No growth on culture.......................	10

TABLE III
AGE DISTRIBUTION

Age Groups	No. Cases	Per Cent
0–5	42	21
6–10	16	8
11–20	37	18.5
21–30	45	22.5
31–40	28	14
41–50	13	6.5
51–60	12	6
61–70	5	2.5
70+	1 (82 yr.)	0.5
Not stated	1	0.5

No Vincent's organisms were reported although Alden believes that this organism is the predominant offender, having recovered it in twenty-four of twenty-six cases secondary to dental disease.

Age Incidence. Two-fifths of our patients were between eleven and thirty years of age. The patients below five years of age comprised another one-fifth of the cases. About one-half of these patients were in the birth to the two year-old group. Patients over fifty years of age constituted less than 10 per cent of our series despite the geriatric nature of admissions to Kings County Hospital.

In 1942 in their series of head and neck infections following oral pathology O'Brien and Rubin recorded only one case in which the patient was below five years of age. One-half of their patients were between

TABLE IV
RACE AND SEX DISTRIBUTION

Sex and Race	No. Cases	Per Cent
Male............................	109	54.5
Female..........................	91	45.5
White...........................	117	58.5
Yellow..........................	1	0.5
Negro...........................	81	40.5
Not stated......................	1	.5

eleven and thirty years of age. Less than 10 per cent of their patients were over the age of fifty. (Table III.)

Race and Sex Distribution. The male and female admission rate in our hospital is 52 and 48 per cent, respectively. The slightly higher incidence of males in our series as compared to females, 55 and 45 per cent, respectively, is comparable to the admission rate. Hence there is no significant statistical difference in the sex incidence.

The white and negro admission rate to our hospital is 73 and 27 per cent, respectively. The incidence in our series of white to negro is 59 and 41 per cent, respectively, This 14 per cent higher incidence of infection in the negro as compared to the admission rate was considered statistically important. (Table IV.)

CLINICAL FEATURES

One-half of the cases involved the head, mainly the face; one-fourth involved the head and neck and the other one-fourth, the neck.

The submaxillary, parapharyngeal and submental spaces were the most frequent sites of infection in the neck, constituting 72, 46 and 35 per cent, respectively. The presence of trismus was used as an indication of parapharyngeal involvement. In Alden's series of 200 cases the distribution

of the site of infection in the neck was similar to ours; the submaxillary space was involved in 70 per cent of his patients. The submental and parapharyngeal spaces each were involved in 25 per cent of the patients which is somewhat lower than the occurrences in our series. (Table v.)

TABLE V
NECK INFECTIONS

Spaces Involved	No. Cases	Per Cent
Submental.....................	20	19.03
Submental, submaxillary and parapharyngeal.....................	15	14.28
	(12)	11.42
Submaxillary and parapharyngeal......	27	25.71
Submaxillary.....................	34	32.38
Parapharyngeal.....................	7	6.66
Submental and parapharyngeal.......	2	1.90
	105	
Submaxillary space.......	76	72.38
Parapharyngeal space..	48	45.71
Submental space.......	37	35.24

The patients were classified in four groups in order to evaluate therapy: (1) mild cases in which infection was localized. Trismus, dysphagia and respiratory distress were absent. Systemic reaction was minimal and temperature was normal or slightly elevated. (2) Moderate cases in which infection was not localized. Cellulitis was present around the involved area. Trismus and dysphagia were slight to moderate. Respiratory difficulty was absent and systemic reaction was moderate. Temperature was elevated, ranging from 98.6 to 102°F. The pulse ranged from 80 to 120. (3) Severe cases in which infection was extensive, usually involving the whole side of the face and/or neck. Trismus and dysphagia were moderate to marked. Respiratory distress was absent or slight and systemic reaction was marked. The temperature was elevated, ranging from 101° to 103.6°F. and the pulse ranged from 90 to 130. (4) Very severe cases in which the patients were extremely ill and very toxic. The temperature was markedly elevated, in some cases as high as 106°F. Trismus and

dysphagia, when present, were marked. Respiratory distress was present in three patients.

THERAPY

The patients received hot soaks locally. Warm saline irrigations were given intraorally in the presence of oral infection every hour during the day. Mild sedation was given for the relief of pain. Supportive systemic therapy was instituted. Fluids were forced by mouth. Intravenous glucose and saline were given to patients who had dysphagia or presenting dehydration. Several blood transfusions were used in those who were very sick to increase their resistance to infection, rarely to supplement the hemoglobin or plasma protein. Seventy-six patients were treated with one of the sulfonamides, usually sulfadiazine, but occasionally sulfathiazole or sulfanilamide. The average dose was 2 Gm. for the first dose followed by 1 Gm. every four hours. Seventy patients received both penicillin and one of the sulfonamides during their hospital stay. These patients were usually the sicker ones or patients who did not respond well to either drug alone. Thirty-five patients received penicillin alone. The average dose was 20,000 units intramuscularly every three hours. Twenty-eight patients received penicillin locally at the site of infection beside systemic penicillin or penicillin-sulfa. The average dose per patient was 56,600 units. The average length of medication for the 200 patients was four to five days.

All patients were treated conservatively. They received chemotherapy and supportive systemic therapy. At the same time they were watched carefully for respiratory embarrassment; oxygen was given to patients who presented respiratory difficulties. No tracheotomy was required. We were able to wait for localization in seventy-seven cases. These patients required only limited incision and drainage or aspiration on the ward. Six of our patients had to be taken to the operating for major surgical drainage.

Mild Cases—Group i. Forty-three patients were treated in this group. Nineteen patients did not require the use of chemotherapy. The average length of their hospital stay was 3.7 days, and 68 per cent excellently responded to local therapy. Local therapy consisted of hot soaks and warm saline irrigations. Seven patients, or 37 per cent, developed suppuration. Five patients had incision and drainage externally and aspiration was done upon two patients. Both patients who had aspiration had excellent results.

Twenty-four patients received chemotherapy, seven patients received penicillin, seven, penicillin-sulfa and 10, sulfa. This group had an average hospital stay of 5.5 days. Patients receiving penicillin and penicillin-sulfa had a higher percentage of excellent results, namely, 85.7 per cent as compared to sulfa, 70 per cent.

Suppuration developed in 35 per cent of the patients. The percentage of suppuration was highest in the patients treated with sulfa, 50 per cent, and lowest in the penicillin-sulfa group, 14 per cent.

External incision and drainage were performed on four patients and intra-oral incision and drainage were performed on three. No aspirations were done in this group.

Moderately Severe Cases—Group ii. Seventy-four patients were treated in this group; fourteen patients received penicillin, twenty-two, penicillin-sulfa and thirty-eight received sulfa. The average hospital stay was 7.4 days. Penicillin-sulfa-treated patients had the longest average hospital stay and the lowest percentage of good response. The best response was noted in the sulfa-treated patients. Suppuration developed in twenty-six patients, or 35 per cent. It was 11 per cent higher in those patients receiving penicillin and penicillin-sulfa than in those receiving sulfa therapy alone.

External incision and drainage were performed on nine patients, intra-oral drainage on four patients, and aspiration on nine patients. Seven of the latter received a local injection of penicillin at the infection site.

Three of them had an excellent response and six a good response to aspiration therapy. One of the aspirated patients required additional external incision and drainage; another drained spontaneously externally.

Severe Cases—Group iii. Seventy-two patients were treated in this group, thirteen patients received penicillin, thirty-three, penicillin-sulfa and twenty-six received sulfa. The average hospital stay was 8.5 days. Those given penicillin had the shortest length of hospital stay and the highest percentage of excellent results. Suppuration took place in thirty-five patients or 50 per cent. Suppuration was much higher in the sulfa-treated group, 61.5 per cent, than in the penicillin-treated group, 23 per cent. Most of the sulfa-treated patients required external incision and drainage while the penicillin and penicillin-sulfa patients had aspiration performed.

Nineteen patients had aspiration performed. Eighteen of them also received local instillation of penicillin. Thirteen of these patients had an excellent response, five had a good response and one had a fair response to aspiration and instillation. Three of these patients drained spontaneously, one externally and two intra-orally. Two had an incision performed and drained externally and two intra-orally.

Very Severe Cases—Group iv. Eleven patients were treated in this group, one patient received penicillin, eight received penicillin-sulfa and two received sulfa. The average hospital stay for this group was 21.7 days. Somewhat superior results were obtained by the use of penicillin and penicillin-sulfa than with sulfa. Suppuration took place in seven patients, or 64 per cent. Six patients had to be taken to the operating room for radical surgery because they did not respond to conservative therapy. This condition in four of the patients happened following tooth extraction, one followed trauma with fracture of the mandible and the other followed an upper respiratory tract infection.

Severe Ludwig's angina syndrome oc-

curred in one of the patients whose condition occured followed tooth extraction. The patient was admitted to the hospital twelve hours after the tooth extraction, with an indurated swelling of the submaxillary and submental area, sublingual cellulitis and trismus. The patient received 100,000 units of penicillin intramuscularly every two hours and 1 Gm. of sulfadiazine every four hours with no improvement. In fact there was extension of the infection into the retropharyngeal space. Lateral x-ray of the neck revealed diminution of the pharyngeal airway to one-fourth of the normal diameter. There was definite respiratory embarrassment for which oxygen was given. A bilateral submaxillary incision was done under local anesthesia and the submaxillary and sublingual spaces were drained thirty-six hours after admission. Resolution of the retropharyngeal and parapharyngeal cellulitis took place. No tracheotomy was required. The patient left the hospital eleven days after admission.

Two patients in group IV had parapharyngeal and parotid space abscesses, one of them with additional involvement of the submaxillary space and the other with involvement of the submental space. Two other patients had a deep, temporal abscess which had to be drained through and through into the mouth.

Two patients in this group were treated by aspiration. One had a submaxillary space abscess from which 14 cc. of pus were aspirated and 95,000 units of penicillin were instilled at the infection site. This patient did not require incision and drainage. A superficial temporal abscess developed in the other patient and despite aspiration, it required incision and drainage.

COMMENTS

The treatment of cellulitis and deep abscesses of the neck was considered purely surgical until recently. Thomas (1908), Mosher (1929), Barnhill (1938), Leonarde (1940) and McCaskey (1942) have stressed the urgent nature of surgical intervention and adequate drainage. Mosher

was of the opinion that to wait for fluctuation was to invite secondary complications. Barnhill advised operation as soon as an abscess was suspected. The cosmetic result has been considered a minor issue when the best drainage was to be obtained.

Resolution has been reported with increasing frequency following conservative therapy in the past few years. Excellent results without use of surgery have been reported by Short (1942) using wet and dry hot packs, Doherty (1941) using the sulfonamide compounds and Herrell and Nichols (1944) using local heat and intravenous penicillin in several severely ill patients with septicemia.

Use of local penicillin in infections has been recommended by Florey (1943). He advised use of penicillin in a closed cavity into which it could be injected and the exudate sucked out periodically. He reported twenty-two cases in which this therapy was used following mastoidectomy of sixteen acute and six chronic cases of mastoiditis. The wound was closed tightly and a fine rubber tube inserted into the upper end of the wound. The exudate was aspirated and penicillin was injected through the tube.

Penicillin was injected every six hours, the solution's strength being 250 to 500 units per cc. The average amount of penicillin used per patient was 17,300 units. Primary wound healing took place in fourteen acute and five chronic patients. The ears were dry within five to ten days after operation. No serious complications occurred.

Peck (1944) reported the use of local penicillin with good results in diabetic patients with gangrene, osteomyelitis of the bones of the feet and carbuncles. He used penicillin in 100 to 1000 units per cc. locally in these cases beside systemic therapy, and he noted marked improvement in the morbidity and mortality rates. In several patients who failed to respond to intramuscular therapy an almost immediate improvement appeared after local penicillin, with recovery in a few days.

Flippin (1945) stated that penicillin may be injected into an abscess cavity after aspiration of the pus and warned against spread of infection by distention of the area of cellulitis. He did not report any cases. Rose and Harwitz (1946) used local penicillin in a series of twenty-four patients, the majority of whom did not receive any systemic or other local therapy. Most of these cases involved the extremities; three patients had perianal infection, four had carbuncles of the neck and one had a carbuncle of the temple. The patient whose condition involved the head received systemic penicillin. The penicillin was injected around the involved area and then toward the center of the infection site. The pus was either aspirated or drained spontaneously.

At the present time treatment of head and neck infections depends largely on the condition of the patient on admission and the extent and nature of the infection. In most cases our treatment is conservative, using local heat, chemotherapy, fluids and small blood transfusions. Surgery is considered in those with very severe cases who require immediate relief if there is an extension of the infection or if the patient shows no improvement despite conservative therapy. If large abscesses are present or form, surgical drainage is also indicated.

In our series of 200 cases only six patients, or 3 per cent, required major surgical intervention. These patients were severely ill and did not respond to conservative therapy. Localization was obtained in seventy-seven patients, or 38.5 per cent, and they required only minor surgical procedures. Suppuration ranged from 35 per cent in the mild and moderate cases to 64 per cent in group iv cases. Patients who received penicillin therapy had a lower percentage of suppuration than those who received sulfa and penicillin-sulfa. However, one must not infer that penicillin-sulfa treatment is inferior to penicillin alone. The combination of drugs was used in the very severe cases and in those who did not respond to either drug alone.

A fairly large number of our patients presented varying degrees of Ludwig's angina. Fifty, or 25 per cent, of the patients had submaxillary, submental and parapharyngeal space infection, with varying degrees of sublingual cellulitis. Twelve of these patients had marked elevation of the tongue and respiratory difficulty. Most of these conditions were secondary to oral disorders. Grodinsky described Ludwig's angina as an infection starting in the floor of the mouth, usually from carious lower molar teeth, and spreading to the submental and submaxillary spaces by fascial planes, with resultant edema of the tongue and glottis, mediastinitis and toxemia. Mediastinitis was not common in our series. Adequate antibacterial therapy may be responsible for this fortuitous circumstance. The mortality rate has varied in different series from 0 to 60 per cent. We had no mortalities. Only one of our patients required radical surgery. Localization took place in twenty-five patients and resolution in twenty-four patients.

Thirty-two patients or 16 per cent of all the patients, had aspiration done; thirty of them received penicillin or penicillin-sulfa systematically and twenty-eight of the aspirated patients, also received local instillation of penicillin. By use of aspiration and local penicillin the percentage of incision and drainage was reduced by 20 to 30 per cent in the moderately severe and severe cases. The average amount of pus aspirated was 10 cc. The average number of days with fever was 4.3 days and the average hospital stay was 11.6 days. The type of patients treated were two with mild cases, nine moderately severe, nineteen severe and two very severe cases. Only five patients required external incision and drainage. In four of them so small an amount of pus was obtained that surgery could have been avoided.

The average dilution of penicillin used was 10,000 units per cc. Rose and Hurwitz report using a solution of 60,000 units per cc. without toxic reaction. The solution was injected deep into the tissues, first around

the area of injection and then into the abscess cavity. The patients usually had aspiration done and were instilled with penicillin every second day until the suppuration disappeared. The only local reaction that developed in some cases was moderate induration at the injection site. This usually disappeared in one to two weeks.

The dosage of local penicillin was increased in our later patients (1946–1947). At present we are using daily injections of 100,000 to 200,000 units with better results. Cellulitis resolves more rapidly with further decreased morbidity. Rose and Hurwitz make the same observation in their patients.

In infections of the head and neck aspiration of the abscess and local injection of penicillin is a valuable adjunct to systemic therapy. The higher concentration of penicillin at the injection site enhances systemic therapy. Aspiration obviates deforming scars from surgical drainage. Clinical judgment must be exercised in cases in which patients require additional measures, such as surgical intervention for spreading infections or large collections of pus which may cause pressure symptoms.

SUMMARY

1. Infections of the head and neck were secondary to infections of the skin, 42.5 per cent, and the mouth, 37 per cent. Upper respiratory tract infections and suppurative parotitis accounted for the remainder of antecedent conditions.

2. Staphylococci and streptococci were the most common invading organisms.

3. Two-fifth of the patients were between the ages of eleven and thirty; one-fifth was below five years of age and less than one-tenth was above fifty years of age.

4. There was a slightly higher incidence of Negro patients in our series as compared to the hospital admission rate.

5. One-half of the cases involved the head, mainly the face, one-fourth involved the head and neck and one-fourth, the neck. The submaxillary, parapharyn-

geal and submental spaces were the most commonly involved spaces in the neck.

6. In order to evaluate therapy cases were classified into four groups: mild, moderately severe, severe and very severe.

7. Suppuration occurred in 35 per cent of the mild and moderately severe cases, 50 per cent of the severe cases and 64 per cent of the very severe cases. A total of eighty-three patients, or 41.5 per cent had suppuration. Of these six patients required surgical intervention. Localization occurred in seventy-seven patients and resolution took place in the remaining two hundred.

8. Patients receiving systemic penicillin had a lower percentage of suppuration than the patients receiving penicillin-sulfa and sulfa alone.

9. Promising results were noted in the thirty-two patients who had aspiration done, of whom twenty-eight also received local instillation of penicillin.

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W. LEMBKE reports a severe case of air embolism which occurred during a thyroidectomy and which was successfully overcome by means of a rather prolonged sucking off of the air that blocks the right heart and interferes with circulation. Two individual punctures and short aspirations of the right ventricle, using a thin cannula and airtight syringe each time, resulted in only transient improvement. Finally the cannula was left in the right ventricle for ten minutes and the air and bloody foam were suctioned repeatedly until the patient regained consciousness, with restoration of normal pulse, color and pupillary activity. Thereafter she had an uneventful convalescence. Surgeons should keep this procedure in mind. One never knows when he himself might encounter such a case and it is well that he knows what to do should the occasion arise. (*Richard A. Leonardo, M.D.*)

SACROCOCCYGEAL PILONIDAL CYST*

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THE term pilonidal sinus, first employed by Dr. R. M. Hodges in 1880, has been carried on in the literature without sufficient critical analysis. Cysts and sinuses in the sacrococcygeal region have been designated by different writers as coccygeal fistula, sacral sinus, postanal dimple or fistula, posterior umbilicus, sequestration dermoid and more recently as raphe coccygeal inclusion. This varied and confusing nomenclature is due primarily to differences in opinion as to the exact embryologic origin of the lesion. These midline cysts and sinuses have been found at all levels of the spinal column; it is thought, therefore, that they should be classified according to anatomic location.

Sacrococcygeal pilonidal cyst has always been considered a minor surgical lesion. Ottenheimer writes: "All of us are confronted from time to time with problems of minor surgery. . . . The treatment of pilonidal sinus justly falls into this category, . . . " Surgical staffs usually refer the surgical management of this condition to less experienced surgeons. In the military service the loss of man-days and hospital beds was so great and so costly that a bulletin was issued by the War Department describing the actual technics to be followed, the types of patients suited for surgery and the plan of postoperative care. The long period of dressings and the high incidence of unhealed wounds present to the surgeon a challenge as yet unsolved. It is startling to review the numerous types of operations devised in the past five years alone for such a so-called minor lesion. The problem is obviously not one of lifesaving but rather one concerned with curtailing the period of morbidity and disability. Permanent cure rests ultimately with the healing of a refractory wound and involves careful surgery and conscientious understanding in the postoperative care.

The first reference in the literature is a letter entitled "Hair Extracted from an Ulcer" written on February 8, 1847, by Dr. A. W. Anderson of Gray, Maine, to the Editor of *The Boston Medical and Surgical Journal* in which he reported the case of a young man twenty-one years of age with a "scrofulous sore upon his back, which he believed would use him up." The data of his examination and treatment follows: "I found, upon examination, a *fistula* opening near the os coccygis, over the left side. I tried to introduce a probe, and then various smaller instruments; but found it impossible, the opening being so small and crooked, to introduce anything into it. I found a tender spot about four inches above and to the left of the opening, which upon pressure discharged two or three teaspoonfuls of mucus mixed with *pus*. After opening the mouth or outlet, I used injections of nitrate of silver and chloride of mercury, and without any perceptible benefit. I then made an opening into a cavity, which discharged the same in quality as mentioned above, intending to lay it open to its mouth, but could not follow the track, for it ran in all directions, or rather branched. I threw injections into the opening which I had made, and they passed out at the natural outlet, but could force nothing the other way, i.e., from the mouth to the wound.

"About three weeks after I made the opening, while at work upon it I drew out a black substance, in a loop form, as large round, when straight, as a large-sized rye straw, and very offensive. I found it was hair, closely matted, and about two inches in length. When it dried, the next day, I examined it again, and found it soft and

fine, the color a dark brown. The discharge stopped, the wound healed rapidly, and he was entirely well in three weeks from the time he lost his hair."

Seven years later (1854) Dr. J. Mason Warren reported three cases of abscess of the buttocks to the Boston Society for Medical Improvement in an article entitled "Abscess, containing Hair, on the Nates." He, too, reported the presence of hair within the abscess cavities and emerging from the coccygeal openings. Following incision and drainage in one case, he noted two channels leading from the main cavity to the adjoining abscesses; this was explained by stating "It would seem probable that originally the hair was contained in a cyst, which, from the irritation caused by sitting, had suppurated, and the pus had burrowed in different directions."

In his paper "Pilo-nidal Sinus," read on November 8, 1880, before the Boston Society for Medical Improvement, Dr. R. M. Hodges referred to the cases of Warren and continued with his own description of the lesion: "A fistulous opening—rarely more than one—over the coccyx, in the immediate vicinity of the anus, and always in the median line, annoys the patient by the itching, irritation, and discharge of pus by which it is accompanied. . . . A director or probe being introduced passes at considerable depth above and below the opening, indicating a cavity of an inch or more in diameter, but does not enter the gut. On exposing its interior by an incision, a certain quantity of pus is evacuated, and a lock of loose hair is found occupying the space, more or less matted or curled, and of varying size and amount. . . . For the development of this rather singular lesion, to which for the sake of designation, I venture to give the name of pilo-nidal sinus . . . "

Coincident with the early descriptions of sacrococcygeal cysts and sinuses numerous suggestions arose as to their mode of origin. Warren believed that there was a change in the polarity of the hairs in the coccygeal region with resulting ingrowth and he wrote: "It would seem possible, however, that it may begin in the stout hair or hairs from a single follicle becoming in some way deviated from their normal direction and inverted upon themselves within the follicle itself; the continued growth of the hair would then result in the formation of a tangled knot or ball of hair which might readily give rise, after a time, to irritation, . . . The occurrence of the disease in the median line between the folds of the nates may, perhaps, be explained by the constant pressure and moisture of the part softening both the newly-formed hair and the epidermic cells surrounding the mouth of the follicle." Hodges described a method by which hairs tended to penetrate the skin and become matted and imbedded: "In view of these several facts there is no occasion for surprise that body hairs, broken off by friction or decay in a pilous region which entangles them and prevents them from falling, should felt and mat together when they have lodged and accumulated in a depression favorably situated for their reception and retention, and subject to so much motion in walking and sitting as the one to which attention has been directed. Neither is it strange that they should, in course of time, excoriate the surface, softened by continuous perspiration, and penetrate or even perforate the integument; nor that, finally by the inflammation and suppuration provoked, they should become a subcutaneous foreign body, the original dimple in the skin degenerating into the fistulous orifices of a more or less extended excavation in the cellular tissue, for which the possessor is compelled to seek surgical advice." .

THEORIES

Nerve Origin. Embryologically, the primitive streak is formed in the third or fourth month of fetal life. Shortly thereafter, a fold appears on each side of it between which arises the medullary groove. These folds develop slowly in height and

incline toward each other in the dorsal midline until fusion takes place; this obliterates the medullary groove and converts it into the definitive medullary canal. (Fig. 1.) This canal becomes the permanent central canal of the spinal cord, and the cells surrounding it become the central nervous system of the full term fetus. During this process of development the spinal vertebrae are forming from primitive mesoderm. Until the third month of fetal life the spinal cord occupies the entire spinal canal; then a rapid growth of the spinal column takes place resulting in the cord being drawn upward to the third lumbar vertebra. Normally the caudal portion of the medullary canal is obliterated during intra-uterine life and is represented at birth by the filum terminale which extends from the end of the spinal cord to the back of the first coccygeal segment.

Tourneaux and Herrmann, Mallory, Gage, Moise, Ripley and Thompson and Kooistra are of the opinion that epithelial cells of the caudal end of the neural tube persist as vestiges which result in the formation of pilonidal cyst and sinus. Mallory states: " . . . in fetuses of 3–6 months there is very frequently present over the coccyx a canal lined with epithelium—in some cases connected with the skin, in others near the coccyx . . . It seems . . . likely that they are due to incomplete obliteration of a former canal, and extending, as they all do, upward and posteriorly to the coccyx, the medullary canal seems the most likely origin." Tourneaux and Herrmann describe the spinal cord as extending at first to the tip of the vertebral column and becoming attached to the skin caudally. At the end of the third month of embryonic development there is marked inequality of growth of the medullary tube and the vertebral column, resulting in the spinal cord being drawn upward. The stretched distal portion is still adherent to the skin and continuous with the rest of the cord. By the fifth month a segment of this is separated from the central nervous system becoming a

tubular structure lined with epithelium known as coccygeal vestiges. This, too, undergoes progressive atrophy. Failure of atrophy to occur, according to them, results in congenital sacrococcygeal tumors and sinuses.
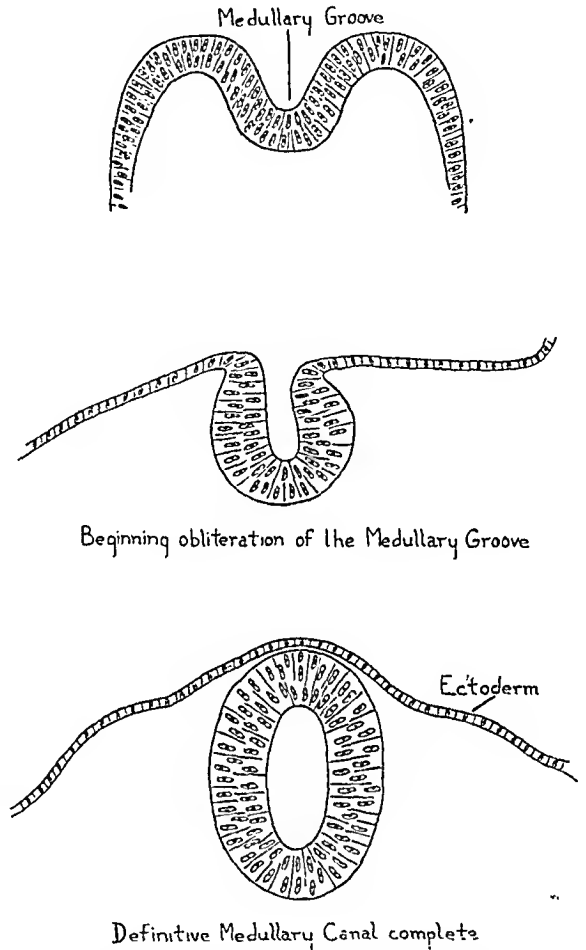
FIG. 1. Development of the neural tube. (From Ranson-Anatomy of the Nervous System, W. B. Saunders Co.)

Oehlecker is of the opinion that in the early embryo the lower three or four caudal vertebrae disappear and become the caudal ligament, a connective tissue prolongation of the spinal column which is attached to the skin. (Fig. 2.) As the caudal vertebrae undergo rapid growth the overlying skin is unable to maintain the same rate of growth and is displaced upward and posteriorly drawing with it the tip of the caudal ligament. By the fourth or fifth month the skin which originally covered the tip of the coccyx lies over the third and fourth caudal

vertebrae; this site is thin, hairless and vascular and is called by him the 'sacral bald spot.' The caudal ligament attached to the skin exerts a pull on it producing a depression, the coccygeal dimple. Combining the ideas of Oehlecker with those of
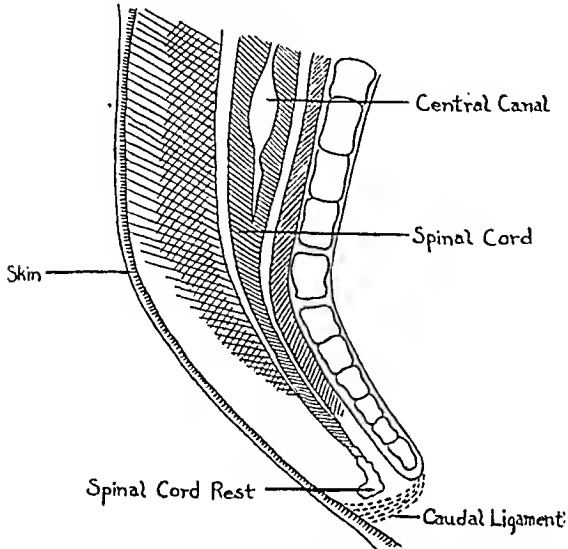
FIG. 2. Development of the caudal ligament. (From Oehlecker. *Deutsche Ztschr. f. Chir.*, 197: 268, 1926.)

Tourneaux and Herrmann, Mims Gage states that pilonidal cysts arise from two distinct embryologic developmental defects, the cyst from vestiges of the medullary canal and the dimple from the attachment of the caudal ligament.

Ectodermal Invagination. Dr. H. B. Stone reports sixty-one cases of 'coccygeal fistula' and, after consultation with Dr. G. L. Streeter, Department of Embryology, Carnegie Institute of Washington, Baltimore, Md., states that pilonidal sinus is the result of a special downgrowth of epithelium from true skin and not from the medullary groove. He compares this structure with other organs formed by special downgrowth, such as the breast and the external ear. In a later communication he compared pilonidal sinus with the preen gland (glandula uropygii) of many species of birds, a structure imbedded in the subcutaneous fat over the lowermost caudal vertebrae. It is a multitubular gland whose tubules converge and empty through an epithelial-lined duct to the skin of the back.

There is often a tuft of fine hair-like feathers about the orifice known as a 'wick.' The direction of the duct from its orifice is up and back as in pilonidal sinus. The gland secretes an oily material which the bird utilizes to waterproof its feathers. It has also been suggested that these glands are primarily scent glands and have to do with sexual attraction.

The main exponent of the invagination theory is Dr. S. L. Fox who studied serial sections in the sacrococcygeal region of the embryo showing various stages of invagination. The condition usually disappears but may persist into adult life. It is derived from budding or growth centers in the basal layer of the ectoderm which give rise to hair follicles and glands. He mentions that it becomes evident after the second decade and is probably associated with development of the secondary sex changes of puberty. Fox admits the existence of coccygeal medullary vestiges but states that they give rise not to pilonidal cysts but to large cystic or solid tumors which are rarely found in infants.

Vestigial Sex-Gland Origin. It is an accepted fact that cysts and sinuses in the sacrococcygeal region are most commonly seen between the second and third decades, a period of intense sexual activity. Dr. H. I. Kallet advances the theory that a vestigial secondary sex gland is located in the coccygeal region: " . . . it might be assumed that a baby may be born with an embryonic remnant of a vestigial secondary sex gland, which is constantly located in the sacrococcygeal region. This gland, apparently, plays a greater role in the male than it does in the female. The embryonic rest, when present during infancy and early childhood, remains quiescent. Then adolescence occurs and under the stimulus of hormones that induce secondary sex characters, the hair on the body etc., this gland, too, is activated; and as it becomes activated, it develops hair. The process continues during early puberty until late adolescence when the hair and the rest of the tumor tend to

undergo degeneration. At this stage, pain, swelling and discharge occur. . . . " Kallet believes there is a definite familial tendency and an unusually large number of twins in the families of those with pilonidal lesions.

CLINICAL FINDINGS

Sacrococcygeal pilonidal cyst with inflammatory involvement is found primarily in the young adult between twenty to thirty years of age although cases have been reported in the newborn and in men beyond the age of sixty. Males are affected more than females in a ratio of 4:1 and brunettes more than blondes in a ratio of 2:1. The incidence is highest in obese, hairy individuals of the hypopituitary type. Any hereditary factor has not been proved yet it is of interest that in the literature there are three references to pilonidal cyst in identical twins (Mechling, Goldberg and Bloomenthal, P. F. Fox). The condition is restricted almost entirely to the Caucasian race with the exception of a few cases in the negro (Smiley, Breidenbach and Wilson, Saleeby and McCarthy). Nationality and occupation seem to make no difference in the incidence of the lesion except that trauma of occupation may be a precipitating factor in the development of symptoms. With the onset of puberty, signs of infection often become evident, and the patient becomes aware for the first time of the 'cyst at the base of the spine.'

The predominant complaints are pain and drainage in the coccygeal region, the degree of pain varying with the extent of obstruction to free drainage. With closure of the sinus openings and development of infection, all the signs and symptoms of acute inflammation are manifest. The swelling is hard and tender and usually located just to one side of the midline over the sacrococcygeal region. In cases with no visible sinus opening there may be some question as to diagnosis. As the abscess continues to develop it may rupture spontaneously through the skin producing adventitious openings in or

near the midline, or it may rupture and burrow through the subcutaneous fat producing sinus openings laterally over the buttock, cephalad over the sacrum or distally about the anus. With subsidence of the acute inflammation, there remains intermittent foul drainage from the original sinus openings and from the adventitious granulating orifices. A history of recurring abscesses in the coccygeal region is diagnostic of pilonidal disease. As a rule about 30 per cent of patients seeking consultation have had previous incision and drainage. Systemic symptoms are very rare, and only occasionally is there a slight rise in temperature, chills, nausea or vomiting. In the few cases reported of continuity between the pilonidal sinus and the spinal canal (Moise, Ripley and Thompson, Shenkin et al.) there have been signs and symptoms of meningitis.

The diagnostic smooth, round sinus opening or openings are found in the midline over the lower sacrum and coccyx. These sinuses are small and usually admit a small probe with difficulty. The sinus tract is directed upward for a distance of 0.5 to 6.0 cm. to the one or more cystic cavities lying on the coccygeal fascia. Secondary sinus tracts extending laterally from the main cyst are often palpable beneath the skin as hard fibrous cords. These terminate in ragged granulating secondary sinus openings. Fine hairs may be seen protruding from the sinus openings particularly in those who have symptoms for the first time. Drainage may be purulent, seropurulent or saniopurulent and in most cases has a very foul, offensive odor. The diagnostic signs of pilonidal disease are abscess formation and one or more midline sinus openings in the sacrococcygeal region.

PATHOLOGY

The midline sinus or sinuses communicate with a simple or multiloculated cyst situated in the subcutaneous fat over the coccyx and firmly adherent to the sacrococcygeal fascia. The sinus and cyst

are lined by stratified squamous epithelium. Infrequently a cyst is present and no demonstrable sinus opening is evident. In true 'hair-nest' cysts the hair is very fine, knotted and curled. The hair follicles in the lining epithelium are destroyed by recurrent infection and do not regenerate. With the onset of inflammation and accumulation of pus, the lining epithelium is also destroyed and replaced by granulation or scar tissue. As pressure increases within the cyst spontaneous rupture to the outside may take place, or the infection may burrow through the fat and then rupture over the sacrum, buttocks or about the anus. The tracts formed by this burrowing are lined by friable easily-bleeding granulation tissue. These sinus tracts never communicate with the rectum except in the rare instance of a coincident posterior anal fistula.

In only a few cases has there been definite evidence of continuity between a pilonidal sinus and the spinal canal. Moise reports a case of staphylococcus meningitis secondary to a congenital sacral sinus in which recovery followed a lumbar laminectomy with drainage; the sinus extended from the skin over the sacrum through a bony defect into the spinal canal. Ripley and Thompson report a case of pilonidal sinus complicated by staphylococcus infection of the meninges; the sinus extended to and communicated with the subarachnoid space. Following excision of the sinus tract and open packing, the infant of three and one-half months expired on the eighth postoperative day. Shenkin et al. report the case of a male child twenty-two months of age who died following spinal cord infection; autopsy revealed a definite communication from a sacral dimple through the filum terminale to the central canal of the cord. Kooistra reports a pilonidal sinus occurring over the third dorsal spine which extended to within the substance of the cord. Most pilonidal sinuses found above the sacrococcygeal region have been found to communicate with the central nervous system and have been associated with spina bifida.

In the early, simple cyst a moderate degree of fibrosis with round cell infiltration of the cyst wall is seen microscopically. As infection and drainage increase a plasma cell and lymphocytic reaction occurs. The fully developed abscess displays gross pus and extensive necrosis with marked neutrophilic invasion. A number of observers (Stone, Fox, Rogers and Hall) have found skin appendages, such as hair follicles, sebaceous glands and sweat glands on microscopic study of excised tissue although Breidenbach and Wilson found no evidence of skin appendages and could not explain the presence of hair.

DIFFERENTIAL DIAGNOSIS

Ischiorectal or perianal abscess occurs as a reddened, tender, indurated swelling lateral to the anus. Like pilonidal abscess it is usually of short duration prior to diagnosis and treatment due to the severe pain which it induces. Occasionally these abscesses run around the anus posteriorly to become horseshoe abscesses and rarely do they point over the lower sacrum. There is a definite systemic reaction with chills, fever, headache, sweating, rapid pulse and leukocytosis. The origin of an ischiorectal abscess is almost universally within the anorectum and the abscess itself is merely one-stage in the development of an anorectal fistula. With the discovery of an internal opening at or near the anorectal line, the diagnosis is incontestible.

Fistula in ano is the last stage in the burrowing of infection from the anorectum through the perirectal and perianal tissues to the skin of the buttocks and perianum. The draining sinus opening is always connected with an opening in the anorectum which may be found by direct inspection through an anal speculum at times with the aid of dye injection. A solid cord palpable beneath the skin represents the tract leading to the anorectum.

The external opening or openings of an anal fistula are not commonly found in the pilonidal region.

Furuncle in the coccygeal region like a furuncle elsewhere is characterized by redness, swelling and pain. As a rule the furuncle is more superficial than is the pilonidal abscess, smaller in size, less painful and much less indurated. There is no systemic reaction and with subsidence of the inflammation there is no recurrence.

Sebaceous cyst is determined by a localized swelling of long duration with no history of persistent drainage. There is no external sinus opening. The contents consist of a thick, white, cheesy material with no odor such as characterizes the purulent contents of a pilonidal abscess.

Unusual Conditions. Chronic infections of the sacrum or of the perisacral tissues such as tuberculosis, osteomyelitis, syphilis and actinomycosis are diagnosed by x-ray examination of the bony tissues and laboratory studies of the purulent discharge. Chordoma arises from residua of the original notochord and pathologically consists of cartilage and mucin. Teratoma is seen at birth and results in a high percentage of stillbirths. Arising ventral to the sacrum, it consists of derivatives from ectoderm, endoderm and mesoderm and characteristically shows extraskeletal bone by x-ray. Meningocele is a soft distensible swelling which transfers a cough impulse. Pressure over the swelling causes reduction in size and bulging of the fontanelle. On paracentesis spinal fluid is obtained. Tumor of the coccygeal gland or gland of Luschka is very rare and is diagnosed only microscopically by the presence of paraganglionic tissue. Tumor of the postanal gut arises rarely when the embryologic neurenteric canal fails to atrophy. This canal is the result of union of the central canal of the cord with the early alimentary canal. The postanal gut is that portion distal to the point of meeting of the proctodeum with the primitive hindgut. This tumor arises ventral to the sacrum and coccyx.

TREATMENT

End results in the treatment of pilonidal cysts have been generally unsatisfactory from the standpoint of morbidity, delayed wound healing and recurrence. The mass of literature which appears each year with new surgical technics and new chemotherapeutic approaches is an indication in itself that the *sine qua non* has not yet been attained. Stone has advised excision of the cyst before the onset of infection describing this procedure as 'sound prophylactic surgery.' Ottenheimer writes: " . . . if the dimpling is patent enough to admit a short probe, operation should be advocated." On the other hand, Barker states that small, non-disabling cysts should be disregarded and only those with recurrent infection should be treated surgically. During World War II this latter plan was finally adopted and enforced by the War Department. The utilization of methylene blue in detecting the extent of sinus tracts has been a bone of contention among many surgeons. In numerous technics of primary closure non-absorbable suture has now replaced chromicized catgut. Sulfa drugs have been tried systemically and locally often along with intramuscular penicillin. Despite everything devised and attempted the cure of pilonidal cyst still remains difficult and the cause of delayed healing and recurrence an unsolved enigma.

Non-surgical Treatment. Sclerotherapy involves application of a sclerosing solution to the cyst and sinus tracts. Cutler and Zollinger and Block and Greene have used modified Carnoy's solution as their fixative, a mixture of absolute alcohol 6 cc., chloroform 3 cc., glacial acetic acid 1 cc. and ferric chloride 1 Gm. Other sclerosants have been applied, such as silver nitrate (Crookall) and fuming nitric acid (Biegeleisen). The fixative is injected or applied to the sinus tract, followed by curettage, repeating the technic every two to four weeks. In some cases the cyst is incised under local novocain and packed with the sclerosant for five minutes every

three to four days. With this type of treatment, healing has been reported in four to ten weeks.

Galvanism has been employed by Maillard in one case with no resulting pain or incapacity. The sinus tract became exfoliated and was replaced by healthy granulation tissue. Treatment in this case took three months, and at the end of six months there was no evidence of recurrence.

X-ray therapy has been suggested by Turell as a substitute for surgery in recurrences of infected sinuses. He has reported two cases of patients with recurrence following surgery who were treated by 650 to 675 roentgen units over a period of six weeks to two months, with subsequent solid healing. Sher states that x-ray treatment should be administered for thirty days as a routine postoperative procedure and advocates 80 roentgen units every three to four days for eight treatments using a 140 KVP with a 3 mm. aluminum filter.

Ambulatory Surgical Treatment. Incision and Drainage: Accumulation of pus in a pilonidal cyst with cessation or diminution in drainage from the sinus openings results in throbbing pain in the coccygeal region, with marked discomfort upon walking and sitting. Occasionally a small probe may be passed through one of the sinus openings facilitating drainage, and this procedure along with hot sitz baths may result in subsidence of the inflammatory process. However, in most cases, more immediate cure of the abscess is accomplished by incision and drainage. Intravenous pentothal anesthesia is ideal for this operation. Whenever possible, incision is made close to the midline resulting in a draining sinus well within the area of later local excision. After reaching the abscess cavity all pockets are broken down digitally and the wound packed with iodoform gauze. Postoperative discomfort is at a minimum. Hot sitz baths are begun the day after operation, and in forty-eight hours the original packing is removed. Drainage is markedly diminished after seven to ten days. Actual excision should not be performed until at least two weeks have elapsed after incision and drainage.

Excision by Hot Cautery: Excision of a pilonidal cyst may be accomplished as an out-patient or office procedure under local novocain anesthesia employing a hot cautery for the excision and control of bleeding. Originally performed and reported by Stanton this technic has been elaborated and developed more extensively by Rogers, Swenson and Sawyer. Incision is made in the midline through the cyst down to the sacrococcygeal fascia. Each half of the cyst is excised separately, the wound packed with vaseline gauze and the patient allowed to go home. After three to four days the original packing is removed, and the wound is thereafter dressed every one to two days as in the open packing method. In a dry field all cyst and sinus tissue can be identified and removed, only a small block of tissue is excised, no infected dead space is left behind and no hospitalization is required.

Hospital Surgical Treatment. Excision with Open Packing: Inasmuch as all draining pilonidal cysts are infected, open packing is considered to be a sound surgical procedure. Kleckner reports that 87 per cent of men with wide experience in pilonidal surgery prefer excision with open packing because of the lowest incidence of recurrence. The greatest objection to open packing is the long period of postoperative drainage and the tedious task of repeated dressings. Under spinal anesthesia a block of tissue including the pilonidal cyst is excised down to the sacrococcygeal fascia or sacrococcygeal ligaments. All bleeding points are tied with No. 0 plain catgut and the wound packed with vaseline gauze. There is very little postoperative discomfort. After three to four days the packing is changed and the patient is allowed to go home. As the drainage becomes foul the packing may be replaced by iodoform gauze. The remainder of the convalescent period consists of

changing the packing every two to three days and constant observation of the wound to prevent premature bridging of tissue with formation of blind scar-tissue sinuses. After two to three weeks the patient may take hot sitz baths twice a day followed by packing. The wound edges should be kept clean shaven. The average healing time is eight to fourteen weeks.

Marsupialization: Originally conceived by Buie and later performed extensively by Coffey and by Peterson, this operation consists in uncapping the cyst and sinus tracts followed by suturing the adjacent skin to the cyst lining. Local anesthesia is adequate. Purulent and necrotic material is wiped away from the sinus tracts, a wedge-shaped piece of tissue is removed between the cyst wall and the skin and the cyst wall is approximated to the skin with cotton or silk. Hot sitz baths are instituted on the day following operation and sutures are removed on the fifth day. The epithelium of the cyst lining with exteriorization gradually assumes the thickness and characteristics of true skin.

Excision with Partial Closure: This operation was performed for the first time by Colp and later by MacFee, DePrizio, Mutschman and others. Its purpose was two-fold: first, to cut down the long healing period of the open packing method and second, to control the difficulties encountered in the various primary closure technics. Two elliptical incisions are made lateral to the sinus openings down to the subcutaneous fat. The skin edges are undercut widely down to the fascia over the gluteus maximus, and the entire block of tissue is stripped from the sacrococcygeal fascia. After control of bleeding the skin edges are approximated to the fascia with interrupted medium silk leaving an open wound ⅛ inch in width. (Fig. 3.) Iodoform gauze is placed over the wound and a firm pressure dressing applied. Sutures are removed in seven to ten days. In this procedure there is no dead space, accurate hemostasis is obtained by pressure

of the lateral skin flaps and drainage is accomplished as a result of the partially open wound. The average healing time is three to ten weeks.

Excision with Primary Closure: When successful, this type of operation is ideal

A.——— Cyst excised and skin edges undercut

B.—Skin edges are approximated to the Sacrococcygeal Fascia

C. ——— Partial closure completed and ready for pressure dressing.
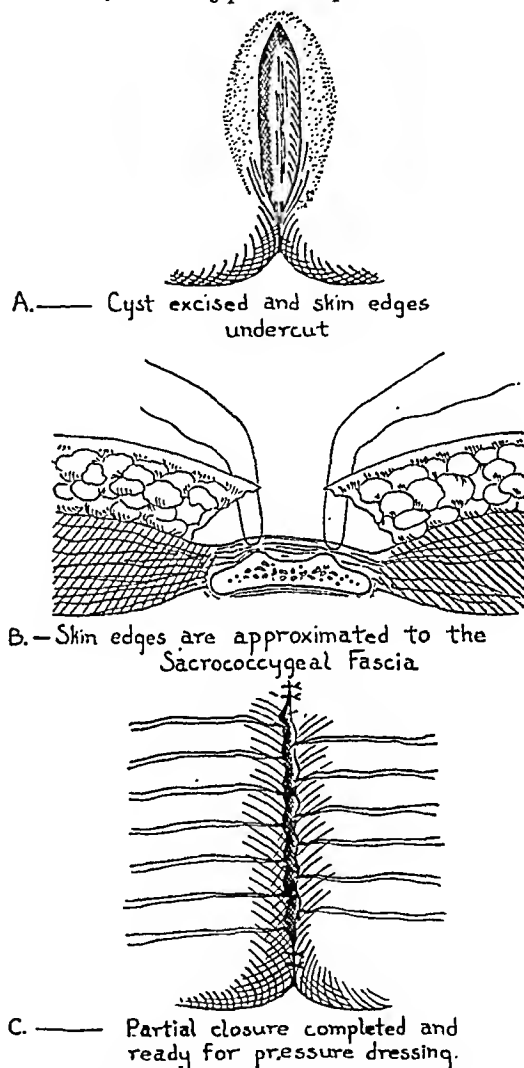
FIG. 3. Excision with partial closure. (From MacFee. *Ann. Surg.,* 116: 691, 1942.)

for pilonidal cyst. (Fig. 4.) There is no necessity for repeated dressings, healing is rapid and the period of disability is reduced to a minimum. No more skin and subcutaneous fat is excised than is absolutely essential to include all sinus tissue. It has been suggested that if the cyst is opened accidentally and the contents spilled, open packing should be substituted. Absolute hemostasis, obliteration of the dead space and prevention of infec-

tion present the greatest problems. The various technics devised and employed have been ingenious, but their number alone bespeak the need for some other method of treatment. (Table 1.)

Gage, Dunphy and Matson employ silk technic throughout for bleeders and for
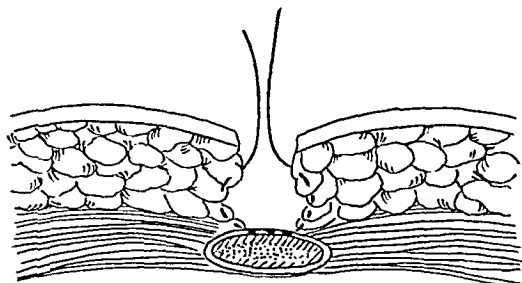
Lowest row of sutures approximates fat to Fascia in the midline
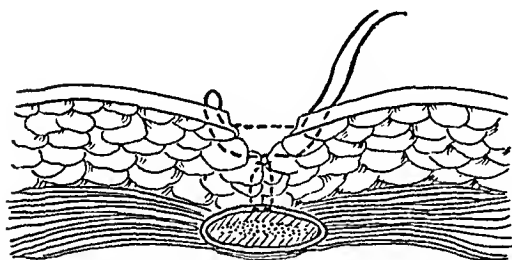
Skin is closed with vertical mattress silk sutures

Fig. 4. Primary closure. (From Ferguson. *Ann. Surg.*, 101: 475, 1935.)

the closure. Dunphy frees the fat from the deep fascia by undercutting, and with the lowest row of sutures fastens the fat to the fascia in the midline. The subcutaneous fat and skin are then closed with vertical mattress silk sutures. He sometimes uses fine steel wire or silkworm gut as retention sutures. Ferguson and Mecray apply retention sutures of alloy steel wire. Woldenberg closes with catgut throughout, sprinkling sulfathiazole powder into the wound prior to closure of the skin. Byrne ties bleeders with fine cotton and sometimes closes the deepest layer with a row of fine cotton sutures; skin and fat are approximated with a figure-of-eight alloy steel wire.

Barber sprinkles the wound with sulfanilamide crystals and then repairs with a deep row of interrupted catgut and a row of interrupted silk; sulfathiazole is given by mouth for twenty-four hours preoperatively and is continued for three days. Barker closes, using heavy nylon

TABLE 1
AVERAGE HEALING TIME (DAYS)

	Open Packing	Partial Closure	Primary Closure	Cautery and Open Packing
Kleckner. .	98			
Kallet..... ..	42–84			
MacFee... .	118	69	70	
Kooistra... ..	?95	..	24	
Swinton and Hodge............	112–365			
Pickett	56–77			
Smiley	56–70			
DePrizio	....	32		
Ferguson and Mecray..........	....	..	17.4	
Dunphy and Matson	....	..	21–28	
Shute et al.....................	....	.	11	
Woldenberg....................	....	..	14	
Brezin.......................	....	..	26	
Rogers and Hall...............	....	..	.....	82
Swenson et al	....	..	.....	100

mattress sutures tied over buttons; sulfanilamide is dusted into the wound and the skin approximated with dermol mattress sutures. Camp and Polites apply three to five retention sutures of No. 8 silk beneath the sacrococcygeal ligament and then close the wound in three layers sprinkling sulfanilamide into each layer. Shute makes lateral incisions through the gluteal fascia which is turned medially and sutured to its fellow of the other side; the lateral sections of the glutei are then approximated in the midline; bleeders are tied with No. 38 stainless steel wire and the wound is closed using No. 32 steel wire. Brezin makes a C-shaped incision reflecting a pedicle skin flap; the cyst is dissected free beneath this flap and the flap is sutured back into place; a mixture of sulfathiazole 10 per cent and cod liver oil 10 per cent in lanolin is applied to the wound as a dressing. Johnson makes a transverse incision in healthy skin above the infected area and dissects the cyst from above downward; dead space is

eradicated by suture through the skin to the coccygeal fascia. Lahey transplants a pedicle flap into the defect to decrease the amount of scar over the sacrum. Swinton has revised this operation by making a V-shaped incision in the buttocks lateral to the defect. (Table II.)

TABLE II
RECURRENCE RATE
(Per Cent)

	Primary Closure	Open Packing	Partial Closure	Cautery and Packing	Marsupialization
Kleckner................	23.29	1.13			
Rogers and Hall..........	36–37	18–25	....	0	
MacFee.................	32.3	16.7	12.9		
Breidenbach and Wilson..	44	6			
Gage...................	0				
Dunphy and Matson.....	6.9				
Ferguson...............	0				
Ferguson and Mccray.....	8				
Coffey.................	....	....	....	..	0
Swinton and Hodge.......	16.6				
Woldenberg.............	2				
Byrne.................	5				

REPORT OF CASES

During the period July, 1944 to September, 1945 a total of ninety-three patients with sacrococcygeal pilonidal disease were treated surgically by the writer at Lovell General Hospital. This series represented only a small percentage of the total number examined. In September, 1944 a War Department Technical Bulletin was issued stating that only those cysts would be excised in which there had been repeated recurrences of acute infection within a short period of time, and that simple abscesses were to be incised and drained followed by return of the soldier to full duty. Other circumstances frequently arose requiring astute judgment as to whether it was worth while from the military standpoint to salvage the soldier. Occasionally men were inducted into the service with draining sinuses and with other defects sufficient to consider them unfit for military service; in such cases prompt separation was effected. Others with persistingly recurrent sinuses after three to four excisions and with coexisting

physical defects were likewise separated. Those conditions treated surgically were as follows: frank abscesses, twenty-nine; primary cysts, thirty; recurrent sinuses, ten and unhealed wounds, twenty-four. It was impossible to follow these patients after release from the hospital so that final and reliable figures are not available.

The average duration of symptoms in pilonidal abscesses prior to surgical intervention was 6.9 days. Intravenous pentothal (500 mg.) was found to be ideal for anesthesia. Local novocain was not adequately effective. Most abscesses were in the midline or slightly to the left. The incision made was large enough to drain the thick, foul purulent contents as well as to admit an exploring finger. Iodoform gauze served the dual purpose of packing and deodorant. Hot sitz baths were started the day following operation and continued until cessation of drainage. Packing was removed in forty-eight hours. The average hospital stay for those returned to full duty was 7.6 days. Of the twenty-nine patients eight had had frequently recurring abscesses within a short period of time; after an average delay of 15.7 days these were subjected to excision of the cyst.

A total of seventy-two excisions was performed of which thirty-eight were in primary cysts, that is cysts not previously excised, ten in recurrent sinuses and twenty-four in unhealed wounds. Recurrent sinuses were those previously excised but still presenting sinus tracts lined by epithelium. Unhealed wounds were granulating surfaces frequently with undermining of the skin edges and with sinus tracts lined by firm scar tissue.

Excision and open packing was performed in nine patients of whom eight had had frequently recurring abscesses and one had numerous draining sinuses due to silk sutures left from a previous operation. This method, the safest in all cases from the standpoint of recurrence, is especially the choice in obviously infected cases. By means of two elliptical incisions carried through the subcutaneous fat to the fascia

over the gluteus maximus and over the sacrum a block of tissue containing the cyst and sinus tracts is removed. Bleeders are tied with No. o plain catgut and the wound packed with vaseline or iodoform gauze. A low spinal is very satisfactory for anesthesia. On the day following operation the patient is ambulatory and starts hot sitz baths two to three times daily. In civilian life a patient is ready to be returned to his home on the third post-operative day. However, in the military service a soldier cannot be released from hospitalization until he is ready for full duty. With open packing, there is a long period of drainage and dressings, but the end result is worth the time and effort. All wounds closed well, with an average healing time of eighty-six days.

The partial closure technic as described by MacFee was performed in twenty instances. Two elliptical incisions are made in the skin close to the sinus openings and the skin then undermined for a distance of 4 to 6 cm. by dissecting away the subcutaneous fat down to the glutcal and sacrococcygeal fascia. All bleeders are tied with No. o plain catgut. The skin edges are sutured to the fascia in the midline with medium silk leaving an open wound about ⅛-inch in width. These silk sutures are left long and used to compress an iodoform gauze dressing to the wound. Nothing but liquids are allowed for one week, the bowels are bound up with paregoric orally and strict bed rest is enforced. On the eighth day sutures are removed, a cleansing enema given, iodoform dressings continued and the patient allowed out of bed. In an occasional case insufficient undermining of the skin results in the skin edges pulling away from the fascia. These wounds are packed and continue to heal as in the open packing method. The average healing time was 55.2 days in seventeen cases. There were three wounds which were not healed in 100 days and must be considered as probable recurrences.

Primary suture when successful is the ideal method of closure of the pilonidal wound. This technic was performed in thirty cases with six failures. Several measures were employed in an attempt to obtain 100 per cent success, but no definite conclusions could be drawn. In eight cases sulfasuxidine was given orally in doses of ½ Gm./Kg. of body weight for the first twenty-four hours and ¼ Gm./Kg. daily for the following seven days preoperatively. Laboratory examination of the stools showed a marked diminution of the colon count, but no accelerative effect on wound healing could be determined. On the day of operation and for the subsequent week sulfathiazole was given by mouth along with intramuscular penicillin in nineteen patients. The remaining three received no chemotherapy. As with partial closures the wounds were not disturbed for one week unless there were signs of wound infection demonstrated by pain, temperature and rapid pulse. On the fifth day sutures were removed in three patients in whom the wounds were found to be broken down, one because of a large hematoma and the other two because of frank pus formation. From then on these wounds were treated by open packing. The usual block excision down to the fascia was performed using catgut technic for ties and sutures. Closure in eighteen cases was completed by three rows of sutures, the lowest of No. 1 chromic approximating fat to fascia in the midline, the middle of No. o chromic for the subcutaneous fat and the top row of interrupted medium silk for the skin. With a large wound defect and difficulty in closing because of increased tension, the subcutaneous fat was dissected laterally from the glutei for a distance of 3 to 4 cm. and these lateral flaps sutured in the midline. Stay sutures of silkworm or of heavy braided silk were used for reinforcement. In twelve patients there were sinus tracts extending to the left of the midline; following excision, all of these side tracts were closed separately prior to closure of the central wound. In the twelfth patient the incision was carried more laterally and a flap moved over to cover the defect.

Firm pressure dressings were applied to all wounds following closure. The average healing time in twenty-four patients was 30.6 days. There were six patients who showed either sinus formation or lack of solid healing at the end of one hundred days and are considered to be recurrences.

SUMMARY

1. "Hair-nest" sinus occurring at the base of the spine is more properly designated sacrocōccygeal pilonidal sinus.

2. The first reference in the literature to the condition is a letter by Dr. A. W. Anderson, Gray, Maine, written to the Editor of *The Boston Medical and Surgical Journal* on February 8, 1847.

3. The term "pilo-nidal sinus" was used for the first time by Dr. R. M. Hodges in a paper read before the Boston Society for Medical Improvement on November 8, 1880.

4. The theory of nerve origin is based on the assumption that remnants of the embryonic neural canal persist as epithelial rests.

5. The theory of ectodermal invagination predicates a special downgrowth of epithelium from the true skin as in the formation of the breast and external ear.

6. The theory of vestigial sex-gland origin assumes the presence of a vestigial secondary sex gland in the sacrococcygeal region which becomes active at adolescence.

7. Sacrococcygeal pilonidal cyst disease is found primarily in hairy, obese, white, male adults twenty to thirty years of age. The predominant complaints are pain and drainage in the coccygeal region.

8. Diagnostic signs are abscess formation and one or more midline sinus openings over the sacrococcygeal joint.

9. Various methods of treatment are discussed. Best results have been obtained by excision and open packing.

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DeQUERVAIN'S DISEASE

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IT is a well known fact that degenerative and inflammatory processes of tendons and their sheaths may give rise to disability but it is not generally realized that such changes may give rise to various clinical syndromes which are not only fairly common but which may be treated by simple surgical measures with almost dramatic improvement. In the past eighteen years a number of very excellent and authoritative reports have appeared in American literature reviewing DeQuervain's disease. Yet this syndrome is infrequently diagnosed although it is common. Recently in analyzing a series of wrist lesions it was noted that thirty-eight cases of DeQuervain's disease had been seen in the past five years, of which thirty patients had submitted to surgery. Because of the excellent end results following operation, it was believed that review of the syndrome would be of value in order to emphasize its frequency and to point out the symptoms and signs that make the diagnosis tenable.

Stenosing tendovaginitis of the radial styloid was first described by Fritz De-Quervain, a Swiss surgeon in Kocher's clinic at Berne in 1895. Following DeQuervain's first article in which five cases were cited, a considerable number of German and French clinicians reported additional cases investigating the condition quite exhaustibly.

The first and most comprehensive report to appear was that by Alfons Eschle of Basle who in 1924 tabulated the 110 cases previously reported in the literature and added nineteen more cases which had come under his observation. While credit is often given to Stein as being the first American author to describe the lesion (*American Journal of Surgery* July, 1927), it was pointed out by Hoffman in 1931 that in May, 1898 he had presented to the American Orthopedic Association a report of twelve cases of "A Common Undescribed Affection of the Extensor Muscles of the Thumb," all of which he had treated conservatively. Schneider in 1928 presented fifteen cases in *Surgery., Gynecology and Obstetrics*. Finkelstein in 1930 contributed to the literature a most comprehensive report on this syndrome, mentioning twenty-four patients whom he had treated and citing experimental evidence to demonstrate that the lesion could be reproduced in animals. In his article the literature is completely reviewed up to 1930. Patterson in 1936 was the first to use the term DeQuervain's disease which according to Cotton has the advantage of brevity and distinction. Cotton, Morrison and Bradford in 1938 presented three cases and pointed out that Hoffman had reported the disease only three years following the appearance of DeQuervain's first article. In 1938 in the *Annals of Surgery* Keys reviewed the subject and presented a case report. In 1943 Potter and Wood added two additional reports, the former citing eight cases.

Frequency. Comprere remarked that this lesion "is not uncommon and is quite disabling, yet there are few reports of these cases and the American literature is surprisingly silent upon the subject." (*Annals of Surgery*, 1933). Cotton stated that while not rare, many cases go unrecognized even in the large surgical clinics and further remarked that "it has received no mention in the classical surgical textbooks, in standard systems of surgery and, except for a minor note, there is no mention of it in the Journal of the American Medical Association." Brown in 1935 wrote that "it is a condition strangely neglected by British writers" while Burns found only one case reported in England up to 1936. It is the belief of all writers that the disease

is common and usually not diagnosed. It is more common in older patients and in housewives. Schneider found 119 women in a series of 135 cases; Finkelstein reported that twenty of twenty-four of his patients were women while in this series thirty patients were women.

Terminology. The term "stenosing tendovaginitis of the extensor and abductor tendons of the thumb" is probably the most descriptive. It has been termed "stenosing tendovaginitis of the radial styloid process" (Finkelstein), "chronic thecitis of the extensor muscles of the thumb," "radial styloiditis," which is not correct, and "stenosing fibrous tendovaginitis" (Kocher).

ETIOLOGY

Predisposing Causes. A positive rheumatic history is infrequently obtained (three of twenty-four patients in Finkelstein's series). However, in this group being reported fifteen patients, or 39 per cent had other rheumatic symptoms. Syphilis and tuberculosis are uniformly absent.

As previously stated the disease is most common in housewives. Fourteen of Finkelstein's patients were housewives while twenty-seven of the thirty-eight patients in this series were housewives. Occupation appears to predispose to this condition. It has developed after prolonged piano playing, the operation of a buffer machine, following excessive washing and wringing out of clothes, fitting rubber rings on a pipe, the use of a typewriter or adding machine, as the result of excessive writing, chopping wood, fly-casting, carrying objects, cutting cloth with heavy scissors, bottle corking, crocheting, boxing, holding a palette, etc. Potter suggests that handling a gun over a long period of time might be a causative factor but no cases have been reported to substantiate this.

Exciting Causes. It is generally believed that the disease is of traumatic origin since it is seen most commonly in the laboring classes and the prevailing opinion in all reports is that the exciting factor must be attributed to chronic trauma. An acute traumatic onset, while it has been reported, is rather infrequent. (In the group reported in this article nine patients stated that the symptoms had their onset after a single injury.) Cotton believes that recurring minor trauma in the region of the radial styloid process or in the overuse of the extensor or abductor thumb muscles may be factors in the etiology. He calls attention to the fact often overlooked that radial abduction of the hand is a function of the thumb extensors almost unaided. Potter mentions that while the exciting cause may be acute trauma, more frequently it is the result of sustained or often repeated active adduction from a position of extreme abduction of the thumb.

Eschle suggests that the cause of the thickening of the tendon sheath over the styloid process of the radius is chiefly a mechanical one. It is produced by increased friction of the tendons of the two muscles over the long groove at the distal radial end. This friction may be increased quantitatively by exertion. One may assume that the tendon sheath becomes edematous which causes further increased friction and that in this manner a vicious circle is formed, the ultimate result of which is a thickening of the tendon sheath. The friction may be increased qualitatively if the normal smooth osseous base is changed by trauma.

Eichoff explains that the cause of many cases is work requiring a constantly repeated movement of the wrist, especially in ulnar abduction, with the thumb fixed on some object. With each movement in this position, the tendons of the extensor brevis and abductor longus muscles become taut over the styloid process of the radius and press upon the tendon sheath which is unable to avoid the pressure because it lies close to the bone. As a second factor during the ulnar abduction of the hand with a fixed thumb stretching of the entire tendon sheath is produced. Extension of the tendons of the two muscles is strongest when the thumb is in opposition to the

hand in middle posture. If the hand with the thumb is now abducted in the ulnar direction, both tendons and the tendon sheaths must be overstretched. A simple experiment will verify this assumption. If one places the thumb within the hand and holds it tightly with the other fingers and then bends the hand severely in ulnar abduction, intense pain is experienced on the styloid process of the radius exactly at the place where the tendon sheath takes its course. The pain disappears the moment the thumb is extended again even if the ulnar abduction is maintained. In cases of forced abduction of the hand without simultaneous involvement of the thumb one does not evoke this pain. Thus repeated overstretching of the tendon sheath results in injury to the gliding mechanism.

ANATOMY

The tendons of the abductor pollicis longus and the extensor pollicis brevis pass together through a compartment of the annular ligament over a groove on the outer aspect of the radial styloid. Careful palpation of the lower border of the anatomic snuffbox in the normal wrist permits identification of these two tendons separately although they are closely approximated and grossly seem to present a single cord beneath the skin. The fibrous and osseous canal through which the tendons glide can be distinguished easily. The canal is lined with a tendon sheath lubricated with synovial fluid. This sheath is about 2¼ inches in length and is strengthened by the addition of some transverse fibers about ⅝ of an inch wide which are dull, pearly-gray in color. At the margin of the sheath the synovial membrane is invaginated and goes over into the tendon as epitenon. The tendon, therefore, is closely connected with the tendon sheath but in such a manner that a certain capacity for motion in one or another direction is permitted. The position of the tendons exposes them to injuries more than others in the forearm. Furthermore, on emerging from the canal together they assume a sharp angulation when the

thumb is abducted; this tends toward mechanical irritation. The first compartment is separated from the second by a bony ridge to which a vertical prolongation of the dorsal carpal ligament is attached.

Histology. The inner surface of the tendon sheath is lined by a flattened layer of cells termed the synovial layer. Immediately outside this synovial layer is a rather loose, cellular, connective tissue containing fine, thin-walled capillaries, and some larger vessels with thin muscular coats (the loose connective tissue layer). This layer gradually fuses with a very dense fibrous and hyaline tissue which corresponds to the annular ligament (the ligamentous layer). There is no separation between the latter two structures; they apparently fuse imperceptibly with each other. The firm, fibrous-like tissue that constitutes the annular ligament is practically avascular and in its more superficial aspect is covered by a thin, loose, connective-tissue layer containing blood vessels (the subcutaneous layer).

Pathology. The one characteristic finding at operation is that the tendon sheath is considerably thickened and that it constricts the underlying tendons, interfering with their normal gliding mechanism. Grossly, the tendons are found to be of less dimension at the point of constriction and are somewhat larger on either side of this area. Effusion is seldom found within the sheath. The latter may be three to four times the normal thickness and densely fibrous, even of cartilaginous consistency; this thickened portion of the sheath is brownish or reddish in color with a loss of the normal pearly luster. Adhesions may exist between the sheath and the tendons or between the tendons themselves. Usually the tendons show no gross pathologic changes. The microscopic pathologic changes described vary considerably. Some authors (DeQuervain, Florcken and Michaelis) found the synovial surface intact while the surrounding fibrous tissue was thickened without any evidence of recent inflammation. Welti and Marion, on the

other hand, found evidence of recent inflammation with cellular infiltration and vascularization as well as an effusion of fluid in the sheath. Obviously the difference in the pathologic reports depends on the stage in which the study was made.

Nussbaum divided the findings into two groups according to Finkelstein: The first group shows an increase of connective tissue in the tendon sheath wall three to four times the normal thickness. The fibers are more condensed than in the normal tissue. The synovial membrane is absent. In the second group the vessels and nerves in the loose connective tissue of the outer layer are infiltrated with numerous round cells. The middle layer consists of interlacing bands of connective tissue and shows a round-cell infiltration of vessels and nerves. Some sections show small, irregular necrotic areas. The vessels are more numerous on the inner side of this middle layer. The lumen end of the tendon sheath is frequently formed of necrotic masses.

Symptoms. The onset is gradual over a period of weeks and months and often the symptoms are out of proportion to the extent of the lesion (Stein). The chief complaint is pain on moving the thumb. The pain, at first dull, may become severe, localizing in the region of the radial styloid, radiating into the thumb and hand and up into the forearm. It is often neuralgic in character and may be worse at night. It is aggravated by motions of the thumb and wrist, particularly thumb and ulnar abduction. The pain is not relieved by medication, rest, or physical therapy and in some patients it is not relieved by adequate splinting in plaster of paris. In severe cases difficulty is experienced in grasping an object, such as a knife, spoon or glass. Patterson mentions weakness of the hand as a characteristic symptom.

In severe cases incapacity may be complete while in milder cases there may be no interference with work. A number of authors have reported this syndrome to be bilateral.

Signs. (1) Swelling over the region of the tendon sheath causing obliteration of the anatomic snuffbox. (2) Distinct, localized, exquisite tenderness over the tip of the radial styloid process. (3) A circumscribed thickening of the tendon sheath may be found on palpation and frequently a cartilaginous thickening is felt over the styloid process situated under the skin, not adherent to the underlying bone and moving with flexion and extension of the thumb. This thickening may reach the size of a pea. (4) Forcible abduction of the thumb is painful. (5) The most pathognomonic sign may be noted on grasping the patient's thumb and quickly abducting the thumb ulnarward. The pain over the styloid tip is excruciating. Also, with the thumb flexed in the palm of the hand and the fingers closed over it, sharp ulnar deviation of the hand causes severe pain in the region of the radial styloid. (6) There are no local signs of inflammation such as heat or redness and there is no crepitation felt on palpation.

X-Ray Findings. X-ray examinations are uniformly negative according to Stein and Finkelstein. Cotton points out that this fact is one more reason for not recognizing the condition when it is present. Brown is one author who reports positive x-ray findings. His patient showed periosteal irritation while Schneider found in two of his fifteen patients that a slight deposition of lime salts appeared over the radius at the site of the fibrocartilaginous disc. He explains this as a "probable extension to the periosteum of the bone in the nature of a proliferative reaction such as one might expect from trauma or inflammation." Such findings are comparatively rare according to Cotton. (Five x-rays in this series revealed a slight periosteal reaction.)

Diagnosis. The possibility of DeQuervain's disease must be considered, especially if the x-ray studies are negative, in a patient complaining of pain in the region of the radial styloid process that has come on gradually without acute trauma and who has no localized signs of inflammation but who has localized tenderness, swelling

and pain on ulnar deviation of the hand, the thumb being flexed in the palm.

Differential Diagnosis. Because there is so little general knowledge of this subject, the condition has been erroneously diagnosed as rheumatism, neuritis, periostitis, tenosynovitis and tuberculous osteitis. Cotton points out that this condition is usually considered as a sprain or rheumatism.

Burns and Ellis state that the condition may be confused with a fracture of the scaphoid bone because of tenderness in the anatomic snuffbox but mention the history and x-ray as being of value in ruling out this possibility. Burns states that sprain of the external lateral ligament of the wrist causes the diagnosis to become more difficult. However, the cardinal physical finding in differential diagnosis is the presence of a bulbous swelling over the radial styloid process. The disease has never been found to be of tuberculous or luetic origin.

Finkelstein in discussing the differential diagnosis reviews the most likely conditions that might be confused with DeQuervain's disease and differentiates between them. Tuberculous tendovaginitis is less often primary than secondary, occurring usually by extension from a bone or joint focus. It is characterized by a serous exudate, sometimes forming ganglia of a compound nature; occasionally rice bodies may be palpated and there is distinct crepitation imparted to the examining hand. The lesion is rarely circumscribed. Aspiration of the fluid and animal inoculation may be necessary in doubtful cases. Tuberculous osteitis is extremely rare. It seldom forms a swelling of any special form and when it occurs in this region, the bone itself is tender to pressure and not the tendon sheath. Movement is not particularly painful in the thumb. Negative x-ray findings will nullify this diagnosis. The absence of crepitation during movement of the thumb rules against tendovaginitis crepitans. There are negative neurologic findings and an absence of hyperesthesia to exclude neuritis of the radial nerve branches. Constancy

and uniformity of the complaints and failure of antirheumatic therapy speak against arthritis. Gout, gonorrhea and syphilis are excluded by a negative history as well as blood and x-ray findings.

Prognosis. (1) Palliative measures as a rule are not successful (Keyes). (2) Spontaneous cures have been reported in a few cases but these are not common. (3) Unless properly diagnosed and treated, the condition is progressive and tends toward chronicity. It is not only painful but at times disabling and because it is generally seen in the working classes, it may seriously affect the economic status of the patient (Finkelstein). (4) Hoffman stated that some of his patients had had symptoms for as long as two years and had passed through the hands of several surgeons without a correct diagnosis. (5) "A review of the literature on end-results following operative intervention is impressive. No failures have been recorded; nor is there any mention of recurrence in patients operated upon" (Finkelstein.) The latter author, however, has recorded two cases with recurrence after operation. (6) Cotton and Eschle both believed that prognosis following operative treatment is good.

TREATMENT

Although as Cotton points out opinion in the recent literature unanimously favors surgical treatment, several authors have reported successful results following conservative treatment. The only non-operative treatment worthy of trial is prolonged immobilization of the thumb and forearm in a plaster cast but the percentage of recurrence may be high (Patterson).

Schneider reported eight of fifteen patients cured by plaster immobilization but the length of postoperative observation is not stated. Two of his patients in whom such treatment failed to effect a cure were relieved by operation. Hoffmann treated all his patients conservatively, that is, he used a well fitting plaster of paris splint extending from the tip of the thumb to the middle of the forearm, with the thumb in full ex-

tension and abduction. He stated that the immobilization method gave uniformly good results in six weeks to six months.

Palliative measures often are not successful in severe or long-standing cases. The ideal treatment is operation and this is true even in the early cases in many instances since operation is a simple surgical procedure, promises immediate cure and avoids the prolonged disability of plaster of paris immobilization. This is particularly impressed by Comprere, Keyes and Cotton. Of sixty-six cases reported by Eschle sixty-five patients were cured by operation and one improved. Finkelstein believes that in the acute stage conservative treatment could be tried in the form of plaster of paris, compression bandage or splint, baking and massage, diathermy, counterirritants applied over the swelling and potassium iodide internally. If relief was not obtained within a period of four weeks, operative treatment was indicated.

Operative Technic. Under local anesthesia an incision 2 inches long centering over the radial styloid process is made. A small branch of the radial nerve runs superficially across the field and is identified and retracted. The carpal ligament and the tendon sheath are identified and incised. The compressed tendons are thus released. Some operators merely slit the sheath and others remove a longitudinal strip while some advise complete removal of the entire circumference of the tendon sheath. The superficial fascia and skin margins are approximated and a compression bandage is applied for several days. No splint is necessary. In two or three days full motion of the thumb may be started. The patient may return to light work in two weeks and to heavy labor in three to four weeks.

COMMENTS

Thirty-eight cases of stenosing tendovaginitis of the radial styloid process have been seen in the past five years. At first the treatment was directed toward conservative management chiefly in the form of plaster of paris immobilization, with the thumb in full extension and abduction. However, it was soon apparent that disability was prolonged and relief was by no means complete. Therefore, it was thought that immediate surgical intervention should be advised and accordingly the patients in question had the stenosed sheath incised. The difference in end results was promptly apparent. All of the patients operated upon had immediate relief following surgery. As will be seen from the Table 1 nine of these patients gave a history of a single trauma with an immediate onset of symptoms. One of these patients had a Colles' fracture and complained of pain along the radial styloid process as soon as the cast had been removed at the end of the fifth week. The average age of this group was 52.9 years. The majority of disabilities occurred in females as has been noted in other reports. Twenty-seven of the thirty-eight patients were housewives and all but one stated that they had used their thumb excessively in their work. There was no significant predilection for one side. One patient had bilateral symptoms although operation was carried out on only one side since the symptoms in the other wrist were very mild. Fifteen patients in this series had rheumatic symptoms elsewhere in addition to the disability in their wrist. Two of the patients (Cases 14 and 38) had only mild pain but both of them had a visible enlargement over the styloid process. Associated pathologic findings were found in two patients one having a mucoid degeneration of the long extensor of the thumb and the other having a ganglion appear after operation. Pathologic studies both grossly and microscopically were not at variance in any case with the findings reported by other authors. In all but one of the operated patients the anesthetic used was 2 per cent procaine and the patients were discharged from the hospital immediately following surgery. The degree of pain that is present along with the fact that this procedure is carried out under local anesthesia without hospital admission

TABLE I

Case No.	Sex	Age	Duration of Symptoms	Occupation	Side	X-rays	Trauma	Other Symptoms	Treatment	Result	Remarks
1. B. E.	M	59	3 mo.	Machinist	Right	Slight periostitis	None	Yes	Operative	Symptom-free	Ganglion appeared postoperatively; also had mucoid degeneration of the long extensor of the thumb
2. J. L.	M	50	8 mo.	Machinist	Right	Calcification along sheath	None	No	Operative	Symptom-free	
3. K. S.	F	70	3 mo.	Seamstress	Left	Negative	None	No	Operative	Symptom-free	
4. D. L.	M	28	3 mo.	Butcher	Right	Negative	None	No	Operative	Symptom-free	
5. C. M.	M	60	6 mo.	Laborer	Left	Periosteal irritation	Yes	No	Operative	Symptom-free	Had mild pain developing on left side
6. S. W.	F	50	3 mo.	Housewife	Left	Negative	Yes	No	Operative	Symptom-free	
7. M. C.	F	44	2 mo.	Seamstress	Right	Negative	Yes	No	Cast	Improved	
8. B. F.	F	51	4 mo.	Housewife	Right	Periosteal irritation	None	No	Operative	Symptom-free	
9. I. F.	F	60	3 mo.	Housewife	Left	Periosteal irritation	None	Yes	Operative	Symptom-free	
10. M. G.	F	60	3 wk.	Housewife	Right	Negative	None	Yes	Cast	Unknown	Never returned
11. E. J.	F	58	3 mo.	Housewife	Left	Negative	None	Yes	Cast	Unimproved	Refused operation
12. D. G.	F	36	4 mo.	Housewife	Right	Negative	Yes	No	Operative	Symptom-free	
13. K. A.	F	32	2 mo.	Housewife	Left	Negative	Yes	No	Operative	Symptom-free	
14. C. B.	M	75	2 mo.	Retired	Right	....	None	Yes	None	Unimproved	Pain was not severe
15. G. S.	F	55	5 mo.	Housewife	Right	....	None	Yes	Operative	Symptom-free	Had done considerable crocheting
16. M. J.	F	55	2½ mo.	Housewife	Left	Negative	None	Yes	Operative	Symptom-free	
17. W. C.	F	70	2½ mo.	Housewife	Left	Negative	None	No	Operative	Symptom-free	
18. E. H.	F	67	4 mo.	Housewife	Right	....	Yes	Yes	Operative	Symptom-free	
19. C. S.	F	62	4 mo.	School teacher	Left	....	None	None	Operative	Symptom-free	
20. A. P.	M	39	6 mo.	Laborer	Left	....	None	Yes	Operative	Symptom-free	Numerous intrathecal adhesions found
21. W. C.	F	33	3 wk.	Housewife	Right	....	None	None	Operative	Symptom-free	
22. G. K.	F	27	3 mo.	Housewife	Right	Negative	None	Yes	Operative	Symptom-free	
23. G. H.	F	68	4 mo.	Housewife	Right	....	Yes	Yes	Operative	Symptom-free	
24. A. S.	F	61	3 mo.	Housewife	Left	....	None	No	Operative	Symptom-free	
25. C. D.	F	62	3 mo.	Housewife	Right	....	None	No	Operative	Symptom-free	
26. J. N.	F	60	3 mo.	Housewife	Left	....	None	Yes	Operative	Symptom-free	
27. L. W.	F	45	3 mo.	Housewife	Left	Negative	None	Yes	Operative	Symptom-free	Had done considerable knitting
28. F. C.	F	41	1 mo.	Housewife	Right	....	None	No	Operative	Symptom-free	
29. B. G.	F	42	3 mo.	Housewife	Right	....	None	No	Operative	Symptom-free	
30. A. B.	F	64	2 mo.	Housewife	Right	....	None	No	Operative	Symptom-free	
31. A. S.	M	46	5 mo.	Grinder	Right	Negative	None	Yes	Operative	Symptom-free	
32. R. L.	F	53	6 mo.	Housewife	Left	Negative	None	No	Operative	Symptom-free	
33. C. H.	F	54	3 mo.	Housewife	Right	....	None	No	Operative	Symptom-free	Had done considerable crocheting
34. G. K.	F	65	3 mo.	Housewife	Left	....	None	No	Operative	Symptom-free	
35. B. O.	F	58	11 mo.	Housewife	Right	Negative	Yes	No	Operative	Symptom-free	Had a direct fall on outstretched hand
36. R. C.	F	46	3 wk.	Housewife	Right	....	None	No	Operative	Symptom-free	
37. W. M.	M	26	3 mo.	Mechanic	Left	Negative	Yes	No	None	Unknown	Seen in consultation for insurance examination
38. H. S.	F	38	3 mo.	Housewife	Left	....	None	No	None	Unknown	Pain was mild

influences these patients to submit to immediate surgery. The average duration of symptoms in this series was 3.4 months. In no case had the diagnosis been made prior to orthopedic examination which again emphasizes the fact that while common, this syndrome is not well known. In reviewing the x-ray studies five patients were found to have changes, chiefly in the nature of periosteal reaction. In one case there was marked osteoporosis in the region of the radial styloid process but in this instance there was no periosteal reaction. Two patients in whom, postoperative numbness developed improved in a few weeks but the appearance of this symptom indicates the importance of not injuring the branch of the radial nerve that courses over the styloid process. The end results to date in all patients have been excellent.

SUMMARY

1. DeQuervain's disease is a common affliction of the wrist which is infrequently diagnosed.

2. It may lead to marked disability due to pain in the thumb, wrist and forearm.

3. It is most common in middle-aged women, appearing in those who use their wrist and thumb excessively.

4. Chronic trauma is the most frequent exciting cause although in this series nine patients noticed symptoms after a single injury.

5. The symptoms, signs, x-ray findings and differential diagnosis are considered.

6. Incision of the thickened sheath under local anesthesia assures prompt relief and early and complete functional restoration.

7. The literature is reviewed, particularly those articles which have appeared in American journals.

8. Thirty-eight cases which have been diagnosed in the past two years are summarized.

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PENETRATING WOUNDS OF THE ABDOMEN *

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DURING one phase of the Okinawa Campaign a series of twenty-two patients with penetrating gunshot and shrapnel wounds of the abdomen were observed and treated.† All these patients were operated upon although the outlook in several cases was extremely poor. The patients were followed eight to fifteen days before being transferred to other Base and Fleet Hospitals (Navy). Cases in which abdominal exploration was negative were omitted from this series. This group with negative findings at laparotomy included two wounds of the rectum for which colostomy was done, one chest wound with abdominal physical findings and one abdominal wound with no intra-abdominal involvement.

The surgical facilities at the Field Hospital were adequate in most respects. Whole blood was plentiful and was used freely. Three patients received transfusions of 5,000 to 6,000 cc. of whole blood during the preoperative and operative periods. At least one unit of blood was given to every patient that showed any evidence of shock. The response of the lowered blood pressure to whole blood was of some prognostic significance. In the postoperative period blood was used to combat shock, and plasma and serum albumin were used systemically as a source of protein until adequate nourishment could be taken by mouth. Continuous gastric suction and penicillin were used routinely in the postoperative care. Penicillin was supplemented with intravenous sulfadiazine when advanced peritonitis was present.

Long right or left rectus incisions were found to be the most satisfactory for a quick, thorough exploration of the ab-

domen. Transverse and oblique incisions in our hands were more time-consuming and did not give as adequate exposure. We did not hesitate to make a "T" extension to improve the exposure. The one evisceration that occurred was in a case with a long rectus incision with a "T" extension. The longitudinal portion of the incision opened but the transverse portion remained closed.

Cotton was used as the basic suture material. It proved to be satisfactory except that its tensile strength was sometimes inadequate. Catgut was used in bladder wounds and in the parietal peritoneum. Otherwise cotton, No. 40, No. 60 and double No. 40, was used throughout. Interrupted sutures were used unless the patient's condition required a more rapid method of closure.

The control of hemorrhage was the first objective as the peritoneum was opened. This was accomplished by clamping major bleeding vessels, removing a lacerated or torn spleen, and in a lacerated liver or kidney by suturing muscle into the wound. Lacerations of the diaphragm were repaired early in the procedure to improve the mechanics of respiration. Wounds of the bladder were repaired with two rows of interrupted chromic No. 2 catgut sutures and a suprapubic cystostomy was done. Perforations of the stomach and small intestine were closed transversely with interrupted No. 40 cotton sutures unless the damage was so extensive that resection became a necessity. End-to-end anastomosis was done when segments of small bowel were removed. The suture lines in small bowel were difficult to identify when opportunity for examination (either at reoperation or autopsy) arose on the seventh, eighth and fifteenth postoperative days.

TABLE I

SUMMARY OF CASES

Case No.	Lesion	Hours after Injury	Result	Cause of Death	Treatment	Complications
1	2 holes in transverse colon, 2 in splenic flexure, 2 in stomach, retroperitoneal hemorrhage	3	Lived	. . . .	Closure of holes with cotton, two layers	Superficial wound infection; pelvic abscess
2	Long deep laceration of dome of liver with hemorrhage	6	Lived	. . . .	Exploratory laparotomy; suture of rectus muscle in liver tear	Bronchitis
3	Bullet wound of chest, laceration of liver, minimal hemorrhage	6	Lived	. . . .	Exploratory laparotomy	None
4	Four large holes in cecum, one in ascending colon	3	Lived	. . . .	Exploratory laparotomy; closure of holes in cecum and colon	Infection of bullet wound, incision good
5	Two holes in rectum, one in bladder and sigmoid colon; ten holes in small bowel, completely divided, gangrenous with hemorrhage	6	Lived	. . . .	Resection all but 3 ft. small bowel; closure of hole in sigmoid, colostomy; end-to-end anastomosis small bowel	Superficial wound infection; rectovesical fistula
6	4 holes in small intestine; sigmoid blown away; two holes in transverse colon; compound fracture of ilium	5	Lived	. .	Resection sigmoid; inversion rectum; transverse colon exteriorized; proximal sigmoid exteriorized; resection, anastomosis small bowel	Osteomyelitis of ilium
7	Shoulder wound; large sucking chest wound; lacerated diaphragm; torn spleen; lacerated kidney; large hole in jejunum; severe hemorrhage	11	Died 15 days postoperatively	Atelectasis, pneumonitis	Splenectomy, nephrectomy, repair of diaphragm, chest, small intestine and shoulder	Subphrenic abscess, pneumonia, evisceration 8th postoperative day
8	Right colon blown to bits, 4 holes in small intestine	10	Died 14 hr. postoperatively	Fulminating peritonitis	Right colectomy; ileostomy; repair holes in small intestine	
9	Cerebral concussion; anterior and posterior holes in stomach; retroperitoneal hemorrhage	5	Lived	. . . .	Closure of holes in stomach	None
10	Penetrating wound of chest, high into dome of liver; laceration kidney; slight bleeding	8	Died 3 days postoperatively	Biliary peritonitis	Exploratory laparotomy	
11	Penetrating wound of chest, hole in diaphragm, lacerated spleen, two holes in transverse colon, hemorrhage	—	Lived	. . . .	Splenectomy; repair of holes in colon; repair of diaphragm and chest	None
12	Fractured tibia; lacerated liver; minimal bleeding	6	Lived	. . . .	Exploratory laparotomy	None
13	Two holes in cecum, two in transverse colon; mesentery torn from 18″ small bowel; compound fracture of ilium	3	Lived	. . . .	Cotton closure of colon holes; resection, end-to-end anastomosis of small bowel	Superficial wound infection
14	Badly lacerated left kidney; retroperitoneal hemorrhage; chest wound with hemorrhage	8	Lived	. . . .	Exploratory laparotomy; rectus muscle sutured into kidney laceration	Hemothorax; intravenous pyelograms 8th postoperative day showed good function
15	Anterior and posterior holes high in stomach; sucking chest wound; localized areas peritonitis	8	Lived	. . . .	Stomach sutured; chest closed in layers	Slight wound infection
16	Small bowel with 8 holes and completely divided; large holes in sigmoid and completely severed; peritonitis	16	Died 12 hr. postoperatively	Fulminating peritonitis	Exteriorization sigmoid; resection, anastomosis small intestine	
17	Left colon blown to bits; small bowel gangrenous; lacerated spleen with severe hemorrhage	15	Died 12 hr. postoperatively	Fulminating peritonitis	Splenectomy; left colectomy and colostomy; resection, anastomosis small bowel	
18	Lacerated spleen, moderate hemorrhage; two holes in stomach with peritonitis	15	Lived	. . . .	Splenectomy; repair of holes in stomach	None
19	Two holes in ileum; two holes in sigmoid; two holes in bladder	4	Lived	. . . .	Bladder holes closed extraperitoneally; suprapubic cystostomy; repair small bowel and sigmoid	Wound infection
20	3 holes in cecum, 2 in jejunum, 4 in splenic flexure. Lacerated spleen, diaphragm; severe hemorrhage; sucking chest	3½	Died 7 days postoperatively	Jaundice, anuria	Splenectomy; repair of diaphragm; repair holes in colon, small bowel; repair of chest	Hemopneumothorax; wound infection; jaundice, anuria
21	Sucking chest; diaphragmatic herniation of stomach, spleen, colon, omentum; lacerated spleen with hemorrhage; holes in stomach and colon	8	Died during surgery	Respiratory failure	Splenectomy; closure of holes in diaphragm, stomach and transverse colon	
22	Sucking chest; two holes in stomach, two in colon; hole in diaphragm; lacerated spleen with hemorrhage	6	Lived	. . . .	Splenectomy; repair of diaphragm; suture holes in colon and stomach; repair of sucking chest	Hemothorax; slight infection of chest wound

Wounds of the colon were repaired when possible with two rows of interrupted cotton sutures. When large areas were destroyed resection or exteriorization was done. Some cases required simple closure of other perforations as well. Of nine patients who had perforations of the colon repaired by simple closure, seven lived and showed no evidence of breakdown of the repaired bowel. One patient died of respiratory failure near the close of the operation. One died on the seventh postoperative day of severe jaundice and anuria. At autopsy the seven repaired perforations of the large bowel were found closed without evidence of leakage or peritonitis. There were four cases with large bowel so badly damaged that exteriorization or resection was done. One patient lived following resection of the sigmoid colon and exteriorization of the transverse colon. Of the three who died, one had a severely damaged right colon and two had a severely damaged left colon. The mobilization of these shattered portions of intestine for exteriorization involved bringing out the proximal and distal normal bowel and resecting the intervening bowel fragments. Each of these patients had fulminating peritonitis at the time of surgery and died twelve to fourteen hours postoperatively.

Early ambulation was instituted on the first postoperative day unless contraindicated by shock or intrathoracic bleeding from a chest wound. Sixteen of the twenty-two patients were up on the first day after operation. There were no ill effects from early activity in patients with varying degrees of peritonitis. On the contrary, the effects on abdominal distention and peristalsis seemed beneficial. Improvement in function of the cardiorespiratory system and in the morale of patients was marked. Patients with associated chest wounds sometimes developed a thready pulse and complained of faintness and weakness. This was considered an indication for discontinuing early activity.

Among the various complications which developed were eight low-grade wound in-

fections, one osteomyelitis of the ilium, one severe bronchitis, one atelectatic fibrotic pneumonia, one jaundice with anuria, one evisceration, three hemothoraces, one subphrenic abscess, one pelvic abscess, one

TABLE II

RELATION OF SURVIVAL TO NUMBER OF ABDOMINAL ORGANS DAMAGED

No. Viscera Injured	No. of Cases	No. Who Lived	Per cent Survival
1	7	7	100
2	8	5	62.5
3	7	3	43

rectovesical fistula and one bile peritonitis. (Table I.) Seven of the eight wound infections occurred in cases with colon injury. The two lung conditions (Cases 2 and 7) developed in spite of penicillin and early ambulation. The evisceration occurred on the eighth postoperative day in a man (Case 7) who had been ambulated on his first postoperative day. However, the evisceration took place while he was in bed having a stomach tube passed during a violent fit of retching. The rectovesical fistula in Case 5 was known to be present at the time of surgery, but the patient's condition permitted only the intra-abdominal procedure with drainage of the perineum. There were no pulmonary emboli noted in this group.

The mortality in these twenty-two cases was 31.8 per cent. Three patients with severe injury to the colon requiring resection or exteriorization died of fulminating peritonitis twelve to fourteen hours postoperatively. These patients had had unusually long, rough ambulance rides due to a sudden advance of the front lines. They arrived late in shock and responded poorly to multiple transfusions. One patient with a sucking chest wound, herniation of stomach, spleen and colon through the diaphragm, a badly torn spleen and perforations of the stomach and transverse colon died of respiratory failure near the close of the operation. Positive pressure anesthesia was not available. One with a laceration of the posterolateral aspect of

the dome of the liver died on the third postoperative day of bile peritonitis. The abdomen was not drained in this case. One died on the seventh postoperative day of severe jaundice and anuria which

TABLE III
FACTORS INFLUENCING SURVIVAL

Time between Injury and Surgery (hours)	Associated Chest Wound	Colon Injury	Result	Time Lived after Surgery	Cause of Death
6	No	No	Lived		
6	Yes	No	Lived		
3	No	Yes	Lived		
6	No	Yes	Lived		
5	No	Yes	Lived		
5	No	No	Lived		
7	Yes	Yes	Lived		
6	No	No	Lived		
8	Yes	No	Lived		
8	Yes	No	Lived		
15	No	No	Lived		
4	No	Yes	Lived		
6	Yes	Yes	Lived		
3	No	Yes	Lived		
3	No	Yes	Lived		
11	Yes	No	Died	15 days	Atelectasis and pneumonitis
10	No	Yes	Died	14 hours	Fulminating peritonitis
8	Yes	No	Died	3 days	Bile peritonitis
16	No	Yes	Died	12 hours	Fulminating peritonitis
15	No	Yes	Died	12 hours	Fulminating peritonitis
3½	Yes	Yes	Died	7 days	Anuria, hepatitis
3	Yes	Yes	Died	Died on table	Respiratory failure

developed five days after operation. He had received twelve transfusions of whole blood. No cross matching had been done. One patient died on the fifteenth postoperative day of an atelectatic fibrotic pneumonitis following an evisceration and development of a subphrenic abscess.

In Table II the relation of survival to the number of abdominal organs damaged is shown. The large bowel from the cecum to the rectum is considered as one abdominal organ. Thoracic wounds and fractures are not included in this comparison. In seven cases in which only one viscus was injured the survival was 100 per cent. In eight cases in which two different organs were damaged the survival was 62 per cent, and in seven cases with three viscera involved only 43 per cent survived.

Of those who died, all had either penetrating chest wounds, wounds of the colon or both. Seventy-one per cent had perforations of the large bowel, 57 per cent had penetrating chest wounds and 29 per cent had both. The mortality in thirteen cases having large bowel injury was 38 per cent. The mortality in nine abdominal cases with associated chest wounds was 44 per cent.

That the time between injury and surgery is important (Table III) is suggested by the fact that the three patients who died of fulminating bacterial peritonitis reached the operating room ten to sixteen hours after injury which involved the colon. In contrast, all those with colon injury who lived reached surgery in three to seven hours. Omitting the death from respiratory failure on the table, the average time interval between injury and surgery for the patients that died was ten and one-half hours; for those who lived it was six hours.

SUMMARY

A summary of twenty-two cases of perforating wounds of the abdomen is presented. The mortality was 31.2 per cent. Factors which appear to affect the mortality rate in this series are the time interval between injury and surgery and the number of abdominal organs damaged.

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USE OF CONCENTRATED PLASMA IN LATE TOXEMIAS OF PREGNANCY*

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USE of concentrated plasma in the severe, late toxemias of pregnancy has been reported[4,5] and the results to date have been most gratifying. Since the last report, concentrated plasma has been used on three additional patients, with good results from the standpoint of urinary output. There was, however, one death after the use of plasma in a patient subjected to a cesarean section. The urinary output in this patient became adequate after use of concentrated plasma. She died five hours postoperatively but the cause of death could not be ascertained even after a complete postmortem examination.

The *modus operandi* of concentrated plasma is still not fully understood as the increase in the osmotic pressure from the additional plasma should be comparatively small. From previous work by Dieckmann and Wagner,[3] Roscoe and Donaldson[7] and Rowntree and Brown[8] it has been shown that there is an increased circulating blood volume in normal pregnancy. In toxemias of pregnancy it has been shown that there is a diminished blood volume, hemoconcentration and hypertension.[2] When the filtration pressure is increased (hypertension) and associated with a diminished osmotic colloidal pressure, the flow of urine should be increased. This is not the case in toxemias in which the effective filtration pressure is not in force due to hemoconcentration and generalized vasoconstriction which will include the afferent vessels of the glomeruli.[1]

We have reason to believe that the addition of concentrated plasma will alter this condition[9] by bringing additional fluid from the tissue spaces into the vascular system thus increasing the circulating blood volume, decreasing viscosity and rendering the blood more easily filterable by the glomeruli. If this is true, we must conclude that in normal pregnancies we have a hemodilution and in the late toxemias of pregnancy there is a hemoconcentration. How much hemodilution is brought about by the introduction of a relatively small amount of concentrated plasma is not known.

Little work has been done on the circulating blood volume in pregnancy using Evans blue as the dye. Miller, Keith and Rowntree,[6] Dieckmann and Wegner[3] and Rowntree and Brown[8] used congo red and vital red. It is believed that experiments with these dyes are subject to a greater error than experiments with Evans blue because of colorimetric difficulties.[10,11]

The author has in progress a series of experiments using Evans blue to determine the unknown factors. The experiments will include determinations of: (1) Circulating blood volume in normal pregnancy ante partum and post partum. (2) Circulating blood volume in the normal and toxic patient before and after administration of hypertonic glucose solutions. (3) Circulating blood volume before and after administration of concentrated plasma in normal pregnancy and in late toxemia with anuria and severe oliguria.

Primary output is to be correlated with each of these experiments.

CONCLUSIONS

From our observations to the present time an increase in the circulating blood volume results from administration of concentrated plasma.†

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B. ERIKSON reports thirty-eight cases of tuberculous endometritis occurring in Denmark. Apparently the disease was limited in each case to the uterus and was diagnosed only postoperatively on the basis of the histologic findings of the curettings. In no instance was the lesion diagnosed preoperatively. About half of these patients had metrorrhagia. Others complained of sterility, a disagreeable leucorrhea, vague pelvic pains or dysmenorrhea and, occasionally, postmenopausal uterine bleeding. Some of the patients were hysterectomized while others received x-ray therapy or ultraviolet radiations. Tuberculous salpingitis has been reported in some of these cases as a sequela. For this reason some gynecologists recommend a hysterectomy once the diagnosis of tuberculous endometritis is made. Therapy is uncertain but radiation may be effective if the rest of the genitourinary tract is free of tuberculous infection. (*Richard A. Leonardo, M.D.*)

SKIN TRACTION IN GUILLOTINE AMPUTATIONS

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WHILE it is relatively safe to do plastic revision of guillotine stumps which are still granulating, there is added insurance of a good result if the stump end is first covered with epithelium. However, in using the conventionally de-

FIG. 1. Conventional method.

scribed methods of applying skin traction, many weeks or months are required to achieve complete healing of the stump end. During this period the patient is a semi-invalid, frequent change of dressings is required and final fitting of a prosthetic appliance is delayed. During the war the occasion presented itself for the development and use of a method of applying skin traction which materially shortened the time required to cover stump ends for final revision.
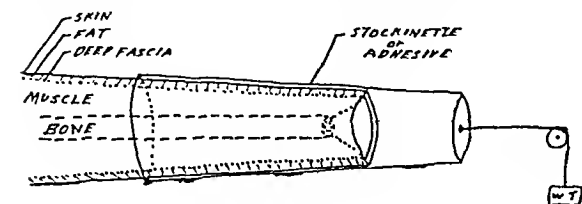
Conventionally, stockinette or wide adhesive strips are applied to the distal six or eight inches of the stump, using some adherent material directly on the skin. A vaseline gauze dressing, overlapping the skin a little, is generally applied to the stump end and traction is applied through a spreader of wood or metal, using pulleys and weights.

The use of this method entails these mistakes: First, it must be remembered that the area of skin actually adherent to the stockinette cannot stretch; therefore, this section merely slides as a tube over the deep fascia of the stump and its elasticity cannot be used for added skin length. Second, the skin and deeper structures pulled down are either held as an open tube by the spreader or are passively allowed to fall together slightly over the stump end.

The method herein advocated consists

of traction to only the distal 4 or 5 inches of stump skin and also actively folds this skin over the stump end. The procedure is as follows: As soon as feasible after operation, perhaps within a week, the stump is thoroughly cleaned. All vaseline or other
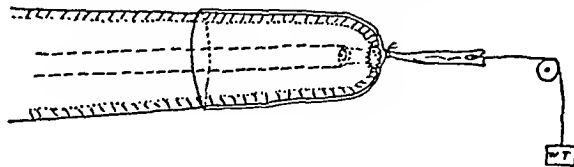

FIG. 2. Suggested method.

grease is completely removed with ether so that all the skin is clean and dry. "Ace Adherent" is applied to the distal 4 or 5 inches of skin only. It must go no higher and it must go all the way to the raw surface. No dressing is applied to the stump end. Sterile stockinette to fit the limb closely is applied over the "Ace Adherent." This should be about 1 foot longer than the stump. A knot is tied in the stockinette a few inches from the stump end and the rope for traction is tied to this knot and over a pulley at the foot of the bed. Moderate traction of this rope is made by an assistant.

Next a piece of string or gauze bandage is tied around the stockinette at the level of the skin edge. As this knot is tightened, it will slip distally a little but will draw the skin down closely over the stump end. A cotton elastic bandage is snugly wrapped about the stump end so as to hold the stockinette firmly to the skin. Ten pounds' weight is applied to the traction rope and left constantly in place for about one week. Traction must be constant which means the patient is confined strictly to bed for this week. Almost daily additional ligatures are placed tightly around the stockinette, close to the stump end, to hold the skin firmly over the raw surface. Usually in about a week the stump is almost covered with skin, and at this time weight may be decreased and used intermittently. Dressings, if required, are placed over the stockinette.

UMBILICAL HERNIA

A SIMPLE METHOD OF REPAIR

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A NOT uncommon finding in the newborn is some degree of umbilical hernia. Most of these are amenable to correction through the use of adhesive tape strapping. Of the group remaining uncured after a reasonable trial of conservatism, a large number can be corrected by a very simple surgical procedure. An aperture not to exceed a fifty cent piece (3 cm.) limits the selectivity for the following technic:

An incision is made down to the fascia from ⅜ to ½ inch long about ½ inch from the edge of the facial ring laterally. Dissection is carried out with an aneurysm needle around the circumference of the fascial opening undermining the skin and subcutaneous tissue down to the fascia. No. 1 silk on a large curved needle is used to pass a suture through the opening of the skin and subcutaneous tissue to grasp the fascia. A half circle is now followed a small distance from the edge of the aperture taking several bites in the fascia. The needle is brought out through the skin directly opposite the skin incision. A finger is kept in the hernial opening to prevent passing the needle too deep. A return of the needle through the skin perforation is now done and the remaining half circle of the fascial hernia picked up by the needle. Both limbs of the suture are now back out through the skin incision. By means of a sawing motion of the silk that portion remaining close to the skin at the point of perforation directly lateral to the skin incision is brought down to the level of the fascia. A second suture using a slightly wider circumference is next put in place. With an assistant's finger inverting the hernia, the sutures are individually pulled up and tied; thus closing the opening. The ends are cut close to the knot. Closure of the subcutaneous tissue and skin complete the operation.

Results over a two-year period have been uniformly successful. One child developed an abscess around one of the silk knots which was too close to the skin surface. Removal of this suture effected a cure with no deleterious results to the repair. The oldest child repaired by this method was six years of age.

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MODIFICATION IN TECHNIC OF ESTABLISHING TEMPORARY TRANSVERSE COLOSTOMY*

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WITH the voluminous literature already extant on the subject of transverse colostomy, it may seem presumptuous to report what is considered to be an improvement in the technic of this comparatively simple and more or less standardized procedure. However, the innovation, when introduced at this hospital, received the unanimous approval of the entire surgical staff and has since been used to the exclusion of all other technics. Various other methods had been employed and although no serious difficulties had been encountered, none was as satisfactory as the one herein described.

The indications for the temporarily diverting colostomy have been set forth so clearly and repeatedly and have been standardized so well that reiteration is not indicated. The type of incision and anesthesia, the direction in which the bowel is opened, etc., will depend upon the preference of the attending surgeon as indicated by the status of the patient in question. It is believed that by opening the bowel at right angles to its long axis, a more diverting colostomy is provided, probably due to the fact that the longitudinal muscle bands tend to retract when severed and in so doing pull the lips of the stoma further apart. It is also believed that it is not necessary to cut the bowel completely through, and it has been repeatedly noted that with a properly constructed colostomy there is little dumping into the distal bowel. Fecal matter which may spill over is adequately removed by a few irrigations administered prior to the next stage procedure. (Fig. 1.)

The technic is simple. An ordinary test tube is pulled into the middle of an adequate length of medium caliber Penrose drainage material. It is found that the test tube fits easily and snugly. Heavy black silk ties are placed around the Penrose

FIG. 1. Photograph of colostomy constructed by method described.

drain at either end of the test tube and tied very tightly. This can be done by the scrub nurse and held in readiness on the instrument table. The bowel is delivered, an aperture made in the mesocolon and the Penrose drain with the incorporated test tube pulled through. The free ends of the Penrose drain are then sutured to the skin. Although customarily the wound is closed in layers, through-and-through sutures are used when there is suspicion that prolonged distention or pulmonary complications with cough will ensue.

CONCLUSIONS

It is believed that the method has the following advantages: (1) It is simple and the required materials are standard in any operating room. (2) The test tube cannot slip out from under the colostomy because the sutured ends of the Penrose drain fix it in place. (3) By placing folded gauze under the test tube the colon can be elevated to a higher level than can be obtained by other methods described. This affords a considerably higher diaphragm between the proximal and distal loops and increases the degree of diversion of the fecal stream. Also, the likelihood of retraction of the colostomy is thereby decreased.

❦

RECENTLY, favorable results have been reported by several authorities who have used large pieces of tantalum mesh to cover exceptionally large defects of the abdominal wall. The mesh becomes surrounded by a dense area of scar tissue which is attached to firm fascia all around the defect and a firm and very satisfactory closure is attained.

(Richard A. Leonardo, M.D.)

Case Reports

NITROGEN MUSTARD THERAPY*

CLINICAL STUDIES ON THE EFFECTS OF METHYL-BIS (BETA-CHLOROETHYL) AMINE HYDROCHLORIDE UPON VARIOUS TYPES OF NEOPLASTIC DISEASE

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SINCE the observation that mustard gas has a cytotoxic effect upon tissues and the more recent observation that the new analogous nitrogen mustards also induce a marked cytotoxic action, the possibility that these drugs might be utilized for the treatment of cancer has been entertained by a number of investigators.

In 1935 Berenblum demonstrated inhibition of tumor induction by mustard gas.[1] In 1946 Gillman and Phillips investigated the effects of nitrogen mustard upon neoplastic disease in man.[2] Since then several reports have appeared in the literature describing the effects of nitrogen mustard upon certain types of cancer. Goodman, et al. and Jacobson and his co-workers[3,4] have reported on the effects of nitrogen mustard compounds upon lymphomas. Rhoads, in a recent report containing the official statement from the Committee of Growth of the National Research Council, described the effects of nitrogen mustard upon 160 patients. He stressed also the effects of the drug upon lymphomas.[5]

Since the appearance of these reports, interest has been high and expectations great concerning the efficacy of this chemical therapeutic agent upon various other neoplasms. Accordingly, a study was undertaken to evaluate the therapeutic effect of the nitrogen mustards upon a heterogeneous group of cancers. In this study methyl-bis (beta-chloroethyl) amine hydrochloride was utilized exclusively. Throughout this report the term methyl-bis or nitrogen mustard shall be used to denote the drug first mentioned. The chemical and biologic properties, including the intermediary products of metabolism, of nitrogen mustard have been described and will not be discussed in this presentation.[6]

METHOD

Dosage. The dose of methyl-bis employed was as follows: One-tenth of a mg. per Kg. body weight was given daily for four consecutive days. This constituted one course of treatment. The powdered drug was dissolved in normal saline solution so that 1 cc. of solution contained 1 mg. of the drug. The average daily dose was 6.5 mg. The solution was introduced usually into the tubing of a saline venoclysis which was running rapidly into the circulation. This method of injection is quite painless. When the drug was injected directly into a vein, pain was associated frequently with its injection but was not severe.

In all instances clinical appraisal of the effect of nitrogen mustard was preceded by a careful history and usually by histologic confirmation of the disease type. Each of the patients who received the drug had exhausted all other specific therapeutic

methods of combating the neoplasm. These included either surgery, irradiation therapy or both. Many of the patients were critically ill and some were preterminal. Radiographs were taken before and immediately after administration of the drug

TABLE I

CLINICAL EFFECT OF METHYL-BIS UPON ONE HUNDRED PATIENTS WITH MISCELLANEOUS MALIGNANT NEOPLASTIC DISEASES

Type of Neoplasm Treated	No. of Cases	Palliation			Decrease in Tumor Size	Decreased	Living
		None	Mild	Marked			
Bronchiogenic carcinoma..............	26	18	6	2	1	15	11
Carcinoma of gastrointestinal tract.....	11	10	1	0	0	6	5
Lacrymal gland carcinoma.............	1	1	0	0	0	0	1
Parotid gland carcinoma..............	1	1	0	0	0	1	0
Carcinoma of floor of the mouth........	1	1	0	0	0	1	0
Carcinoma of pharynx................	6	6	0	0	0	5	1
Carcinoma of larynx.................	4	4	0	0	0	3	1
Pancreatic carcinoma................	2	2	0	0	0	1	1
Primary carcinoma of liver............	1	1	0	0	0	0	1
Carcinoid, generalized................	1	1	0	0	0	1	0
Hodgkin's disease....................	4	1	1	2	1	1	3
Lymphosarcoma.....................	7	4	2	1	1	4	3
Round cell sarcoma..................	1	0	1	0	1	0	1
Reticulo-endotheliosis................	1	0	1	0	0	0	1
Metastatic carcinoma................ (primary not known)	7	6	1	0	0	6	1
Mediastinal tumor...................	5	4	1	0	1	1	4
Malignant melanoma.................	5	5	0	0	0	2	3
Fibrosarcoma.......................	1	1	0	0	0	1	0
Ewing's endothelioma of bone.........	2	1	0	1	0	1	1
Multiple myeloma...................	1	1	0	0	0	1	0
Neurofibromatosis...................	3	3	0	0	0	0	3
Prostatic carcinoma..................	3	2	1	0	0	1	2
Bladder carcinoma...................	1	1	0	0	0	0	1
Kidney carcinoma...................	3	3	0	0	0	0	3
Testicular carcinoma.................	2	2	0	0	0	2	0
	100	79	15	6	5	53	47

as well as at frequent time intervals subsequent to its administration so that the effect of this medicant upon the size of the mass could be studied. Laboratory studies consisted of peripheral blood studies which included hemoglobin concentration and total numbers of blood cells. Thrombocyte determinations were performed when the patient manifested clinical evidences of thrombocytopenia. Routine urine analyses were performed. Blood chemical studies were made as were deemed indicated during the progress of the study. These included non-protein nitrogen plasma chloride, carbon dioxide combining power, hematocrit and plasma protein determinations.

All patients were hospitalized during administration of the drug and were observed for a minimum of two weeks following cessation of its administration.

Material. This study concerns itself with one hundred patients with miscellaneous types of cancer. The specific types are summarized in Table 1. The following factors were studied to evaluate the effects of methyl-bis: (1) Did the drug produce a decrease in the size of the cancer? (2) Did the drug produce a regression in the natural course of the disease? (3) If there was an effect upon the cancer, were

certain cancers in certain specific localities more sensitive to the agent than others? (4) Did the agent produce palliation in the patients? By palliation is meant any of the following: a decrease in pain as evidenced by the patients' statements or a decrease in the intake of analgesics; a feeling of well being; improved appetite; relief of such symptoms as cough, hemoptysis, expectoration, dysuria, etc; duration of the palliation. (5) What toxicologic manifestations developed?

RESULTS

In order to evaluate the clinical response from methyl-bis the one hundred patients were divided according to the degree of their response. They were placed into one of the following categories: (1) no response; (2) mild response; (3) marked response.

The results are summarized in Table 1 and it may be noted that of the one hundred patients studied, in seventy-nine there was no beneficial response attributable to administration of this therapeutic agent. In fifteen patients a mild response was observed. These cases are summarized in Tables II and III. In six patients marked response was observed. Complete case reports of these six patients are presented.

An attempt was made to ascertain the type of neoplasm which might benefit from administration of methyl-bis.

Bronchiogenic Carcinoma. Of the twenty-six patients with bronchiogenic carcinoma treated, in eighteen no beneficial response was noted. Six patients enjoyed a mild response (Table II) and in two there was a marked response. There was no correlation of histologic type or location of the neoplasm and the response to the drug. The patients with bronchiogenic carcinoma who experienced mild palliation described a decrease in chest pain necessitating less analgesic, a decrease in cough and expectoration and a feeling of well being. However, the duration of this improvement was transient and varied from three days to six weeks. Of the six patients who experienced mild palliation, four have

succumbed from their disease. The medicant apparently had no effect upon the natural course of the cancer. The following case reports describe in detail the sequence of events in two patients with bronchiogenic carcinoma who enjoyed a good response.

CASE I. P. J., was a forty-nine year old white male who presented a complicated history of pulmonary disease which started when he was "gassed" during World War I, after which he became blind and dyspneic for two months. He remained well until December, 1946 when he noticed dyspnea and bilateral chest pain. Roentgenographs revealed a left hilar density diagnosed as bronchiogenic carcinoma. Laryngoscopic examination revealed left vocal cord paralysis. Biopsy of a right supraclavicular lymph node metastases revealed "undifferentiated carcinoma." Prior to methyl-bis therapy the patient complained bitterly of dyspnea, cough and severe chest pain. His appetite was poor and he was losing weight rapidly. The usual course of methyl-bis therapy was given from July 28th to July 31, 1947. He was nauseated and vomited frequently throughout this course of therapy, but at its completion his symptoms were markedly improved. He spent little time in bed and required no narcotics for relief of pain. He gained 10 pounds in the three-week period following methyl-bis therapy; there was slight persistent dyspnea. Because of the good response to the initial course of therapy, a second course of methyl-bis therapy was given from August 19th to August 22, 1947. The patient tolerated the second course of therapy well and there was additional relief from the dyspnea. Laboratory findings were unchanged except for a maximum leukopenia of 3,100 per cu. mm. on August 11, 1947. X-ray examination on August 30, 1947, gave evidence suggestive of a slight decrease in the size of the hilar density. The patient developed a pathologic fracture of the middle third of the left femur on October 10, 1947, and he expired October 17, 1947.

CASE II. G. H. B., was a fifty-nine year old white male who developed severe cough and dyspnea in February, 1947. At the time of admission to Hines Hospital in June, 1947 the patient had developed marked evidence of superior vena cava obstruction as evidenced by dyspnea, orthopnea, dusky cyanosis of the

head and neck and puffy swelling of the face and neck. He was very apprehensive. Roentgenographic studies revealed evidence of a right upper lobe neoplasm. A biopsy from a right supraclavicular lymph node was diagnosed metastatic, undifferentiated carcinoma.

1947. The usual course of 0.1 mg. per Kg. body weight was administered. On the second day of methyl-bis therapy there was dramatic relief from the aforementioned symptoms. The dyspnea subsided, there was decrease in the neck swelling and cyanosis disappeared almost

TABLE II

SUMMARY OF PATIENTS WITH BRONCHIOGENIC CARCINOMA WHO RECEIVED MILD PALLIATION FROM METHYL-BIS

Name and Age	Histologic Diagnosis	Symptoms and Signs	Previous Treatment	Nitrogen Mustard Therapy	Response to Therapy
J. P. 50 yr.	(Undifferentiated carcinoma)	Emaciation, chest pain, draining empyema	Surgical drainage of empyema August 19, 1946; x-ray therapy on 6/23/47–7/25/47	8/23/47–8/26/47	Slight decrease in chest pain, improved appetite, weight gain of 5 pounds; symptomatic improvement of one month's duration, expired November 26, 1947
H. D. 64 yr.	(Squamous cell carcinoma)	Weakness, cough, hemoptysis, pain, hemothorax	None	4/16/48–4/19/47	Feeling of well being for about twenty days; hemoptysis ceased; metastases to 3rd left vertebrae; May, 1947; expired June 26, 1947
P. B. 53 yr.	(Undifferentiated carcinoma) Metastases to skull and sacrum	Severe chest pain, cough, weakness, headache; metastatic nodule in right temporal region	X-ray in June, 1947, with relief of symptoms for one month	8/19/47–8/22/47	Feeling of well being; relief of chest pain; decrease of expectoration; slight decrease of metastatic nodule, temporal region; duration three months
R. F. D. 57 yr.	(Squamous cell carcinoma) Left lung recurrence	Onset August, 1942; severe chest pain; dyspnea	Right pneumonectomy in August, 1942.	4/8/47–4/11/47	Relief of chest pain for three days following therapy, followed by increased pain and dyspnea; expired 4/27/47
J. F. M. 53 yr.	Adenocarcinoma	Onset April, 1944; chest pain; fullness in chest, cough, weakness; exploration of chest October, 1946, (inoperable)	None	7/29/47–8/2/47	Slight decrease of chest pain; slight increase in strength, permitting patient to drive in automobile; decrease in fluid level in left lung; palliative six weeks; expired 10/26/47
E. F. C. 56 yr.	(Squamous cell carcinoma)	Onset May, 1947, weakness, chest pain, right shoulder pain as a result of metastasis to right humerus; exploratory thoracotomy (inoperable)	None	9/29/47–10/2/47	Slight decrease of chest pain; shoulder pain persisted; palliation one month; downhill clinical course continues

Bronchoscopy revealed right bronchial compression and cells aspirated from the bronchial tree were believed to be neoplastic. Methyl-bis was administered from June 7th to June 10,

completely. There was no demonstrable change in the roentgenographic findings relative to the size of the neoplasm. Seven days after the completion of methyl-bis therapy the patient was

TABLE III

SUMMARY OF PATIENTS WITH MISCELLANEOUS NEOPLASTIC PROCESSES WHO RECEIVED MILD PALLI-
ATION FROM METHYL-BIS

| Name and Age	Diagnosis	Symptoms and Signs	Previous Treatment	Nitrogen Mustard Therapy	Response to Therapy
G. H. 51 yr.	Reticulo-endotheliosis	Onset in 1943, with scrotal dermatitis; in 1945 exfoliative dermatitis generalized. September, 1947, severe pruritus, exfoliation, intolerance to cold, weight loss, 20 pounds, daily temperature elevation, 101°1.	August, 1946; superficial x-ray therapy with slight relief; topical ointments	9/2/47– 9/5/47	Exfoliation decreased, pruritus diminished; weight gain 19 pounds; fever ceased; improvement did not commence until one month after nitrogen mustard therapy; the relationship of methyl-bis therapy to a remission one month after therapy is difficult to evaluate
P. B. B. 59 yr.	Squamous cell carcinoma, floor of mouth	Onset in October, 1945; extensive ulceration floor of mouth with fixation of tongue, invasion of mandible; marked emaciation; severe pain in lower jaw	X-ray therapy in May, 1946; suprahyoid neck dissection, October, 1946	7/6/47– 7/9/47	Local tenderness of jaw decreased; less morphine required; slight improvement of general condition, one month; expired 9/3/47
W. R. L. 56 yr.	Metastatic carcinoma, involving right lung and peritoneum; primary not known	Onset in September, 1945; exploratory laparotomy (elsewhere) in September, 1945; massive liver enlargement, ascites, marked weakness, abdominal pain	X-ray therapy to liver mass, October, 1945	4/8/47– 4/11/47	Slight relief of abdominal pain; feeling of well being, two weeks; course of disease unaltered; expired 5/31/47
J. T. T. 23 yr.	Mediastinal mass; type undetermined	Onset January, 1945; dyspnea, feeling of fullness in head, diffuse swelling in both supraclavicular regions; x-ray revealed mediastinal widening; exploratory thoracotomy (elsewhere) in 1945; inoperable	X-ray therapy in 1945 with no relief from symptoms	8/5/47– 8/8/47	Decrease of dyspnea; duration two months
E. G. L. 63 yr.	Carcinoma of prostate with extensive bone metastases	Onset 1942; bed-ridden because of severe pain in back and legs	Transurethral prostatic resection in 1942; estrogens 1942–May, 1946; bilateral orchidectomy in 1945; palliation was good until May, 1946, but estrogens were not relieving pain at the time nitrogen mustard therapy was given	5/7/47– 5/10/47	Relief from pain permitting patient to walk; patient succumbed 5/23/47
J B. 59 yr.	Lymphosarcoma, generalized	Onset 1944; weakness, diarrhea, abdominal discomfort; splenomegaly, hepatomegaly, ascites, enlarged cervical lymph nodes	X-ray therapy in January, 1945, with good response; patient did not return to hospital until May, 1947 when his condition was far advanced; paracentesis, on May 27, 1947, at which time 1,600 cc. milky fluid was obtained	6/5/47– 6/9/47	Patient felt stronger; appetite improved; there was no decrease in the size of the tumor swellings; palliation one month
H. J. T. 31 yr.	Lymphosarcoma	Onset 1945; bilateral hydrothorax, cervical and mediastinal lymphadenopathy; upper abdominal, retroperitoneal left node; osteoblastic metastases to lumbar spine; severe back and lower extremity pain	X-ray therapy to mediastinum with relief from symptoms resulting from obstruction of suppurative mediastinal structures, 1946; x-ray therapy to abdomen January, 1947	4/25/47– 4/28/47	Relief from back pain, necessitating the reduction of analgesics to one-half of previous dose; palliation continued two to three weeks; patient expired 6/29/47

TABLE III.—(Continued)

Name and Age	Diagnosis	Symptoms and Signs	Previous Treatment	Nitrogen Mustard Therapy	Response to Therapy
L. G. R. 31 yr.	Hodgkin's disease with spastic paraplegia	Onset 1943; cervical adenopathy; spastic paralysis in both lower extremities in April, 1947; severe back and abdominal pain	X-ray therapy in 1944 and 1946; laminectomy for compression of spinal cord with partial removal of epidural tumor in 1946	6/1/47– 6/4/47 11/6/47– 11/7/47 (.1 mg./Kg. × 2 daily dose)	Improvement in leg motion followed methyl-bis therapy; there was little or no improvement following laminectomy, only partial return of leg function; feeling of well being persisted four months after the first course of methyl-bis therapy; slight relief from abdominal discomfort followed second course of therapy; second period of palliation was 2 months
C. O. E. 50 yr.	Round cell sarcoma, generalized	Onset January, 1946; numerous tumor nodules in skin, metastases to dorsal and lumbar vertebrae and retroperitoneal lymph nodes; weakness; moderate pain and tenderness in skin nodules	Laminectomy in January, 1947, with partial removal of epidural tumor and relief from partial paraplegia; x-ray therapy postoperatively to involved vertebrae	6/30/47– 7/3/47	Practically complete disappearance of one subcut. nodule which previously measured 2½ cm. in diameter; there was slight decrease in the size of several other skin nodules and the nodules became less tender; palliation persisted six weeks; all the previously present nodules increased in size and others appeared; leukopenia of 2,200 precluded more nitrogen-mustard therapy.
E. E. B. 37 yr.	Carcinoma of rectum with bilateral pulmonary metastases	Onset October, 1945, weakness, cough; multiple pulmonary metastases	Abdominoperineal resection November, 1945	6/2/47– 6/6/47 9/23/47– 9/26/47	Feeling of well being; decrease of cough; palliation five months

given a course of deep x-ray therapy and received 1,950 r. to each of three portals: anterior, posterior and lateral to the right upper chest, the factors being 250 K.V., 2 mm. copper filtration, 50 cm. target skin distance, through 15 by 12 cm. portals. A decrease in the size of the right supraclavicular lymph node metastases was observed. He remained well until August 7, 1947, when the left supraclavicular lymph nodes increased in size, and severe cough, dyspnea and a daily temperature rise to 101.5°F. developed. The patient was given a course of penicillin and sulfadiazine, for what was believed to be pneumonitis but there was no relief. A second course of methyl-bis therapy was given between August 24th and August 28, 1947. Again there was marked improvement. The fever disappeared and there was marked decrease in the dyspnea. The patient became ambulatory and stated that he was "much stronger and was eating everything." He remained ambulatory until September 29, 1947, when he again became increasingly dyspneic, orthopneic and cyanotic. A third course of methyl-bis therapy was administered between

September 29th and October 2, 1947. There was no improvement from the third course of therapy and the patient expired October 23, 1947. This patient tolerated methyl-bis therapy exceedingly well. He did not vomit. The lowest white blood count throughout this period of observation was 5,700 per cu. mm. of blood on August 27, 1947. The lowest recorded red blood count was 3.9 million per cu. mm. of blood on August 30, 1947. This patient enjoyed two excellent remissions with methyl-bis. The drug was without effect for a third exacerbation of symptoms.

Comment. An attempt to supplement an excellent clinical response from methyl-bis with deep x-ray therapy was apparently without effect.

Gastrointestinal Cancer. Eleven patients were treated and in ten no response was noted. In one patient who had a carcinoma of the rectum which had been resected previously and who was suffering from bilateral pulmonary metastasis, a feeling
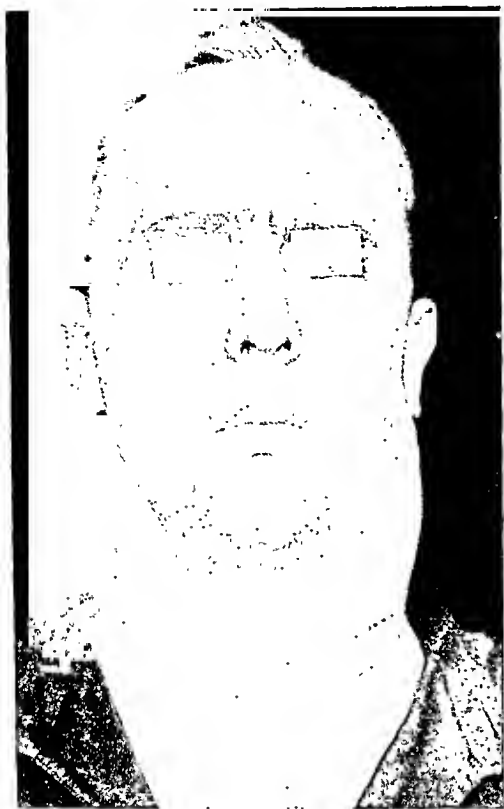
FIG. 1. Case III, C. W. A, Hodgkin's disease producing a large, fixed, cervical mass; B, same patient two months after a course of methyl-bis therapy.

of well being and increased strength developed following administration of methyl-bis. The duration of the remission was one month when the patient developed weakness and thrombocytopenia. He received a second course of methyl-bis from September 23rd to September 26, 1947, with slight palliation. The patient is now a university student maintaining an adequate scholastic record. (Case x, Table III.)

Comment. Although no beneficial effect has been observed from the administration of methyl-bis to patients with gastrointestinal cancer, the palliation noted in a patient with pulmonary metastases from a rectal carcinoma suggests that the metastases may be sensitive to the drug even though the primary lesion is not.

Hodgkin's Disease Four patients with Hodgkin's disease were treated. In one no response was noted. One patient enjoyed mild response (Table III, Case VIII) and

April, 1949

in two marked symptomatic improvement occurred. The following case records describe the patients with Hodgkin's disease who enjoyed marked palliation from methyl-bis.

CASE III. C. W., dated the onset of his illness to February, 1946 when he noticed swelling of the left side of his neck which persisted until September, 1946. A biopsy was diagnosed "typical Hodgkin's disease." He was treated with 400 roentgens of deep x-ray (elsewhere). The swelling disappeared almost immediately after x-ray therapy but recurred within two weeks. At the time of admission to Hines Hospital in July, 1947 the patient was in excellent general health, but had massive lymph node enlargement over the right mid-sterno-cleidomastoid muscle which extended into the anterior and posterior triangles and measured 7 by 6 cm. It was adherent to all contiguous structures. A course of methyl-bis was given from July 23rd to July 26, 1947. On July 31, 1947, the left neck swelling decreased to approximately two-thirds of the original size. Because of the very good initial response, the

patient was given a second course of therapy, consisting of three daily doses of methyl-bis from October 20th to October 22, 1947. Within a week following the second course of methyl-bis, the swelling decreased to approximately one-third of its original size and was freely movable. (Fig. 1A and B.) On September 4, 1947, a small egg-sized nodular mass was excised from the left cervical region. Histologic report of the resected tissue revealed only fibrosis of a lymph node, with occasional small islets of lymphoid tissue. In November, 1947 the patient noticed small lymph nodes in the left side of the neck and in the submental region but he continued to feel well. He was given a third course of methyl-bis therapy from November 4th to November 6, 1947, consisting of three daily doses. There was slight decrease in the size of the aforementioned lymph nodes. A lymph node biopsy in late November, 1947 again revealed only lymphoid tissue and fibrosis. The lymph node was described as being hyalinized. This patient tolerated methyl-bis well and noticed only nausea during the last two courses of methyl-bis therapy. Maximum leukopenia was 3,800 white blood count per cu. mm. on September 3, 1947. The patient remained well until February, 1948 when multiple enlarged lymph nodes were noted again in the left cervical region. This patient is at this writing receiving localized x-ray therapy to these lymph nodes.

CASE IV. P. S., was a twenty-one year old white male who developed an orange-sized swelling in the left side of his neck in December, 1946. Biopsy revealed lymphoma, probably Hodgkin's disease. On July 15, 1947, a left radical neck dissection was performed and 17 gold radon seeds containing 1.9 millicuries each were inserted into residual tumor tissue. On August 1, 1947, the patient developed a nodular metastases in the region of the left biceps muscle which was excised and which revealed Hodgkin's disease. In September, 1947 the patient developed several, diffuse, subcutaneous, painful nodules. The largest of these nodules was located in the right posterior loin and measured 6 by 5 by 3 cm. A mass in the right forearm prevented flexion of the fingers. In addition the patient lost 40 pounds in weight, was very weak and had daily temperature elevations to an average of 101°F. The patient was given a course of methyl-bis therapy from September 21st to September 24, 1947. In the morning of the second day of methyl-bis therapy all of the subcutaneous nodules decreased in size, and one week after completion of therapy several of the tumor nodules had disappeared completely while others decreased to an average of one-third their original size. He felt well for a period of two weeks. His appetite improved, his temperature was normal, he was capable of using his right hand for letter writing and he carried on all normal functions. After this two-week remission the subcutaneous nodules rapidly began to increase and returned to their previous size. On October 20, 1947, the patient's temperature was elevated to 104°F. He became much weaker and pale and on October 27, 1947, he became confused. The patient was given a second course of methyl-bis consisting of 7.7 mg. on November 3, 1947, and an equal dosage on November 4, 1947. Again the subcutaneous nodules decreased in size, this time to an average of one-half their original size. The patient became stuporous, his temperature was elevated to 106°F. rectally and he developed jaundice and suffered severe epistaxis. The preterminal blood picture was 3.5 million red blood cells per cu. mm. of blood, 39,600 white blood cells per cu. mm. of blood, hemoglobin 11 Gm. per cent, 95 per cent polymorphonuclears and only 75,000 platelets. The patient expired November 6, 1947, and autopsy revealed generalized Hodgkin's sarcoma.

Comment. An excellent remission occurred which lasted the short period of two weeks. A second course of methyl-bis was without effect.

Lymphosarcoma. Seven patients with generalized lymphosarcoma were given methyl-bis. In four there was no response following administration of the drug. There was a mild response in two patients which consisted essentially of relief of pain and a feeling of well being. There was no effect upon the progress of the disease or any demonstrable effect upon a decrease of the tumor. (Table III, Cases VI and VII). Another patient enjoyed marked response and his course is described in detail, as follows:

CASE V. F. F. H. was a fifty-five year old white male who suffered shortness of breath

since August, 1945. In September, 1945 a chest plate revealed a mediastinal mass. This patient was treated at Hines Hospital in January and February of 1946 with x-ray therapy which consisted of 2,100 r. to the upper chest, right anterior oblique; 2,250 r. to the upper chest, right posterior oblique; 2,100 r. to the upper chest, left anterior oblique; 2,260 r. to the upper chest, left posterior oblique. The following factors were utilized: 150 r. twice daily, 200 K. V., 1 mm. Cu. filtration, 50 cm. target skin distance, 15 by 10 cm. portal. He enjoyed good palliation. In March, 1947 he was re-admitted with superior vena caval obstruction. He had marked swelling of the face, neck and of the right upper extremity. The superficial veins of the thorax were dilated. Roentgenograph revealed a large mass in the superior mediastinum. A biopsy of a supraclavicular lymph node was diagnosed lymphosarcoma. After admission the patient's dyspnea increased markedly. He complained of double vision and there was extreme cyanosis. The patient refused oxygen therapy because of apprehension. A course of methyl-bis therapy was administered from April 8th to April 11, 1947. There was dramatic relief from symptoms following the first dose of methyl-bis and at the conclusion of therapy the patient was ambulant. He had no dyspnea or cyanosis. Roentgenographs of the mediastinum taken two months after completion of therapy revealed a regression in the size of the mediastinal mass. The palliation was excellent. His only complaints were slight swelling of the neck and a sensation of light-headedness which occurred when he lowered his head. Roentgenographs taken in September, 1947 revealed a slight increase in the size of the mediastinal mass. The maximum leukopenia in this case was 4,100 white blood cells per cu. mm. of blood on April 15, 1947. The patient remains with minimal symptoms at the time of this writing ten months after nitrogen mustard therapy.

Metastatic Carcinoma. Seven patients with diffuse metastatic carcinoma in which the primary lesion was not discovered were treated with methyl-bis. In six there was no response whatsoever to the therapy. One patient manifested a mild response which consisted of relief from abdominal pain and a feeling of well being. (Table III,

April, 1949

Case III.) This response lasted two weeks after which the patient expired.

Pharyngeal Carcinoma. Since pharyngeal carcinomas are usually anaplastic, it was thought that a study to determine the effect of nitrogen mustard upon this neoplasm was indicated. Accordingly, six patients with this neoplastic process were treated with a course of methyl-bis, and there was no response noted in any of the patients. The conclusion is warranted accordingly that this particular neoplasm does not manifest a response to the administration of methyl-bis.

Mediastinal Tumors. Six patients with mediastinal masses were treated with methyl-bis. Of this group one patient suffered from lymphosarcoma and is described under that heading. In the other cases the histologic diagnosis was not established. Of these five patients four did not demonstrate any response. One patient enjoyed mild palliation, (Table III, Case IV) which consisted of a decrease in dyspnea and which lasted for two months. X-ray therapy administered two months previously was without benefit.

Reticulo-endotheliosis. One patient with reticulo-endotheliosis was suffering from severe desquamation of the skin resulting in marked intolerance to cold and causing the patient to remain constantly in a hot room. He was treated with a course of methyl-bis. The patient showed no improvement for about one month after which desquamation ceased and the patient became comfortable. The delayed reaction which is the only one in which this was observed precludes a definite statement as to the efficacy of nitrogen mustard in this particular patient. That it did exert a beneficial effect is suggested by the fact that this was the only modality which was introduced in addition to local ointments which he had been receiving. The possibility of a spontaneous remission cannot be excluded. Additional studies of this type are warranted.

Genito-urinary Neoplasms. In none of the patients who suffered from genito-

urinary carcinomas, which included carcinoma of the prostate, bladder, kidney and testicles, were any significant results noted. Of the entire group only one patient with prostatic carcinoma and extensive bone metastases manifested mild response consisting of relief from pain which permitted the patient to walk after having been bedridden for one month. However, he succumbed two weeks after the completion of the methyl-bis. (Table III, Case v.)

Ewing's Endothelioma. Two patients with diffuse metastases from Ewing's endothelioma received methyl-bis. One patient manifested no improvement or palliation and succumbed shortly afterward. The second patient manifested a dramatic response to the drug and will be presented in detail.

CASE VI.   D. H., was a twenty-six year old white male who entered the hospital on April 7, 1947, complaining of severe backache. The patient dated the onset of his illness to October, 1941 when he developed pain in the right femur. The pain persisted but nothing was done until 1946 at which time a biopsy was taken of the right femur and a diagnosis of Ewing's endothelioma was established. The patient was given a course of deep x-ray therapy to the right femur in May, 1946, with a good roentgenographic response. In April, 1947, because of severe pain in the lumbosacral region due to metastases to the vertebrae, the patient was again given a course of deep x-irradiation therapy with good palliation. The third admission occurred in February 1947, at which time the patient presented symptoms of intercranial involvement and again responded favorably to roentgen therapy. The patient, however, lost weight rapidly and continued a gradually progressive downhill course, until June 17, 1947, at which time he was semicomatose and appeared as if he would not live through the night. The patient was given a course of methyl-bis from June 18th to June 21, 1947, consisting of 0.1 mg. per Kg. body weight. Almost immediately the patient began to improve. He recovered complete consciousness, became oriented and ate well. The response was most dramatic. He has remained in fair condition with a good mental outlook,

although he is extremely weak and bedridden. On August 10th he developed partial paraplegia and was given a course of x-irradiation therapy. He developed a marked leukopenia, the maximum being 1,350 white blood cells per cu. mm. which occurred about two weeks after the completion of methyl-bis therapy. The patient also developed a thromboeytopenia of 15,000 thrombocytes per cu. mm. of blood with clinical evidence of petechiae and ecchymosis. These subsided completely in the interim. The patient succumbed February 25, 1948.

Comment. This case represents a dramatic response in a patient with Ewing's endothelioma and extensive metastases who was semicomatose and whose hours were numbered. The patient remained alive for eight months since initial administration of methyl-bis therapy.

Malignant Melanoma. Five patients with diffuse metastases from malignant melanoma received no benefit from methyl-bis.

Neurofibromatoses. The three patients studied did not demonstrate any palliation nor regression of the tumors. The remainder of the cases are summarized in Tables I and III.

COMPLICATIONS AND TOXICITY FOLLOWING
INTRAVENOUS ADMINISTRATION OF
METHYL-BIS (B-CHLOROETHYL)
AMINE HYDROCHLORIDE

Venous Thrombosis. In no instance in this series was there any evidence of venous thrombosis which resulted from administration of this drug.

Nausea and Vomiting. Almost all of the patients in this series developed symptoms of nausea and vomiting. The symptoms generally occurred within one to four hours after administration of the drug and were usually of a mild nature. In about 5 per cent of the patients the symptoms were severe and persistent for the entire duration of the therapy. In those instances it was important that an adequate intake of food and fluid be maintained to counteract the nausea and vomiting with the resultant decrease intake

of food and loss of that intake. In all such instances blood transfusions, blood and plasma transfusions supplemented with glucose and saline were given intravenously. The symptoms of nausea and vomiting disappeared shortly after completion of the course of therapy. Attempts to counteract the nausea and vomiting by the simultaneous injection of various vitamin compounds including thiamin chloride, pyrodoxine, ascorbic acid or multiple vitamin compounds were without effect. It has been found advantageous to warn the patients that they will experience nausea and vomiting after administration of methyl-bis. In no instance was this complication of serious import, and in no case was it necessary to discontinue administration of the drug because of the nausea and vomiting.

Diarrhea. Diarrhea was observed in four (4 per cent) of the patients in this series. It occurred on the second day of therapy and usually lasted until one day after completion of the therapy. It was never severe and in no case did it preclude administration of additional nitrogen-mustard. The exact nature of this diarrhea is not understood.

Effect upon the Hemapoietic System. In this series it was not possible to obtain a complete record of the effect of methyl-bis upon the hemapoietic system because many of the patients were in a preterminal state and died before it was possible to study the effect of methyl-bis upon the erythron. Many of the patients had severe anemia or leukopenia before administration of methyl-bis and because of the poor clinical status the average patient was supported with blood transfusions before, during and immediately after administration of methyl-bis. Furthermore, in certain instances previous x-radiation therapy produced a depression of the blood constituents. However, certain findings were rather consistent and conclusions can be drawn upon the effect of methyl-bis on the hemapoietic system, with special emphasis upon the effect on patients that are

severely ill and have undergone various traumas to the hemapoietic system from previous radiation, etc.

Anemia. A fall of the red blood count below 3,000,000 cells per cu. mm. was considered anemia and this appeared in nine (9 per cent) of the patients studied in this series. The average onset of the anemia was ten days after the initiation of therapy, the earliest being two days after therapy and the latest was nineteen days after institution of methyl-bis. Certain patients that were critically ill demonstrated a more sensitive tendency toward a depression of the red cells than those in good shape and focuses upon the need to watch severely ill patients more carefully during administration of methyl-bis therapy. In no instance was the depression of the red blood cell count serious and in all instances with blood transfusions and administration of adequate protein, iron and liver extract a steady rise of the red blood cell count was observed.

Leukopenia. Leukopenia with a drop of the white blood cell count below 3,000 cells per cu. mm. was encountered in 1 per cent of the patients studied here. The earliest appearance of leukopenia was four days after the initiation of therapy and in one instance leukopenia appeared twenty-nine days after use of methyl-bis; the average appearance of maximum leukopenia was sixteen days after the onset of methyl-bis administration. The return to normal after leukopenia developed was not as definite nor as rapid as the return of the red blood cell count to normal. It required from one week to one month before the white blood cells returned to a normal level. In this study 1,000 cells per cu. mm. was considered a critical level and if the count dropped to that level, which occurred in 2 per cent of the cases, therapy was stopped. In all other instances after the white blood count had dropped to 5,000 the patient was placed on a prophylactic penicillin regimen and in no instance did infection or other signs or symptoms attributable to agranulocytosis

develop. It was not possible to increase the rapidity of white cell regeneration by any medicant and the only method noted in this series of combating this disorder was repeated, small, whole blood transfusions. The level of the white blood cell count was the determining factor in deciding upon additional courses of nitrogen mustard therapy.

Lymphopenia. Lymphopenia was the most persistent hematologic change noted in this series of cases. It was observed almost uniformly that lymphopenia appeared from one to fourteen days after the initiation of therapy; the average number of days for maximum lymphopenia to develop was three days after completion of treatment.

Thrombocytopenia. Seven per cent of the patients in this series manifested clinical evidence of thrombocytopenia, consisting of petechia, ecchymosis and epistaxis. Routine thrombocyte counts were not performed until a patient manifested clinical evidence and in each of these seven patients a drop in the thrombocyte count was observed. The earliest appearance of thrombocytopenia was two days and the latest appearance was three weeks after the initiation of therapy. One patient, who was home and developed generalized petechia and bleeding from the gums which persisted for two weeks, received no therapy; he recovered to carry on normal activity and he returned to the hospital one month later and manifested a normal blood picture and thrombocyte count. This case indicates a spontaneous recovery of the bone marrow following methyl-bis.

The depressant effect of methyl-bis upon the hemopoietic system is a temporary one and in no instance if the patient survived long enough was there a failure of return of the blood count to a normal level.

Blood Chemistry. Blood chemical studies, consisting of plasma protein concentration, non-protein nitrogen, plasma chloride, plasma carbon dioxide combining power and hematocrit were performed in 50 per cent of the cases in this series and in no instance was any change attributable to methyl-bis encountered. Routine urine studies were performed and no specific alterations were observed.

SUMMARY AND CONCLUSIONS

The effects of nitrogen mustard, methyl-bis (beta-chloroethyl) amine hydrochloride, have been studied upon a group of one hundred patients who suffered from cancer. The series was selected to represent a heterogeneous group of neoplastic diseases so that the efficacy or toxicity of this drug upon patients suffering from various neoplastic processes could be ascertained.

In no instances was the drug considered of curative value, and in seventy-nine patients of the one hundred studied the drug had no effect whatsoever. Fifteen patients enjoyed mild palliation, and six manifested a marked response to the administration of methyl-bis. The results, however, for the most part were of a transient nature; and in all instances in which a decrease in tumor size occurred the decrease was transient usually followed by a return to the previous size of the mass and in certain instances to an increased growth.

The two disease processes which appeared to respond the best to the administration of methyl-bis were bronchiogenic carcinoma and lymphomas. In two of the four patients with Hodgkin's disease treated a dramatic response was manifested by a decrease in the size of the tumor mass with marked transient symptomatic improvement. Patients that are critically ill rarely manifest a beneficial response to the administration of this therapeutic agent.

Studies are under way to note if tumor masses which have decreased in size as a result of methyl-bis administration can be prevented from regrowth by a course of x-radiation.

Although the use of a chemical agent in the treatment of patients with neoplastic disease represents a milestone in

the therapeuces of this disorder, it is believed that methyl-bis is not the drug of choice, but additional studies in obtaining allied chemicals should be continued.

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BORRMANN classifies gastric carcinomas into four general types. The first two types are relatively localized and have a better prognosis if operated upon early enough, whereas types III and IV are spreading or infiltrating and usually in such cases the condition may already be inoperable or reeurrence, at least, is more apt to follow gastrectomy. While all this is relatively true, we must not lose sight of the fact that the presence or absence of metastasis in the regional lymph nodes of these resected stomachs is also of great prognostic value. In fact Moore et al. have recently studied a large number of these cases and justly conclude that this factor is of even greater prognostic value than simple reliance on the Borrmann type of tumor. (*Richard A. Leonardo, M.D.*)

ANGIOSARCOMA OF THE STERNUM*

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SARCOMAS of the chest wall present the same clinical course and poor prognosis as sarcomas in other regions of the body but cases have been reported in which surgical excision has been able to give great relief from rapidly progressing pressure symptoms and to prolong life. There is always at least the possibility of a cure but the general rule is recurrence and metastases. The weapons at hand at the present time to combat the destructive growth and spread of the malignant tumor are surgical excision or radiation or both.

In 1932 George J. Heuer[2] found thirty-seven cases of tumor of the sternum in the literature and added one case. Seven tumors were said to have arisen in the gladiolus, nine in the manubrium and two in the gladiolus and manubrium. The remaining tumors simply are described as being in the sternum. Fifty per cent were primary sarcomas; the rest were chondromas, endochondromas, chondromyxomas, metastic tumors, gumma and chronic inflammation. Three were pulsating tumors and were found to be aneurysms.

Thirty-four of these patients were subjected to a more or less radical operation. Eight died within fifteen days of the operation. Of the twenty-three patients who recovered, only three failed to show evidence of recurrence in from one to two years.

The sternum is a very uncommon site primarily affected by malignant growth. Thomas J. Kinsella[3] quotes a report from Davies that in over 29,000 4 by 5 inch chest films made by the mobile x-ray unit of the Nopeming Sanatorium, St. Louis County, Minnesota, they encountered twelve thoracic tumors. Of these only five were definite chest-wall tumors. In 1933 Carl L. Hedbloom[1] reviewed 313 cases of tumors of the bony chest wall, including Heuer's tumors of the chest wall. These were all the tumors of the chest wall reported since the first thoracotomy was recorded by Osias Aimar in 1778. Eighty per cent were primary in the ribs and only 20 per cent in the sternum. To this 20 per cent, or fifty-two cases of tumor of the sternum, nine more cases were added in a paper by Sommer and Major[4] in 1942. Of these nine cases which included all the reported cases with apparent adequate histologic study, three were Hodgkin's disease, three were chondromas, one was a chondrosarcoma and one was a small, round-cell sarcoma.

Among the malignant tumor groups reported by Sommer and Major there is no case with a five-year cure. The most discouraging group from the standpoint of therapy is that of Ewing's sarcoma, fourteen of eighteen patients having died and one reported living but with recurrence.

Woodward[5] cites a case of sarcoma of the sternum following injury, with death ensuing within three months of operation.

CASE REPORT

The patient, R. O., a fifty-one year old construction worker, was first seen by his physician in December, 1944, for a lump in his chest which developed after an injury caused when a load of wood he was lifting slipped and hit his chest. He complained of pain and shortness of breath. The lump had spread toward the center of his chest and was increasing in size. There was no cough, no sputum nor loss of weight. There was no history of serious illness or operations. A roentgenogram showed a tumor of the manubrium and upper part of the sternum. (Fig. 1.) In February, 1945, a section was removed for biopsy.

The specimen consisted of an irregular piece of white tissue from the manubrium, 0.5 cm. in its greatest diameter. Microscopically, the tumor was very cellular, the cells varying from
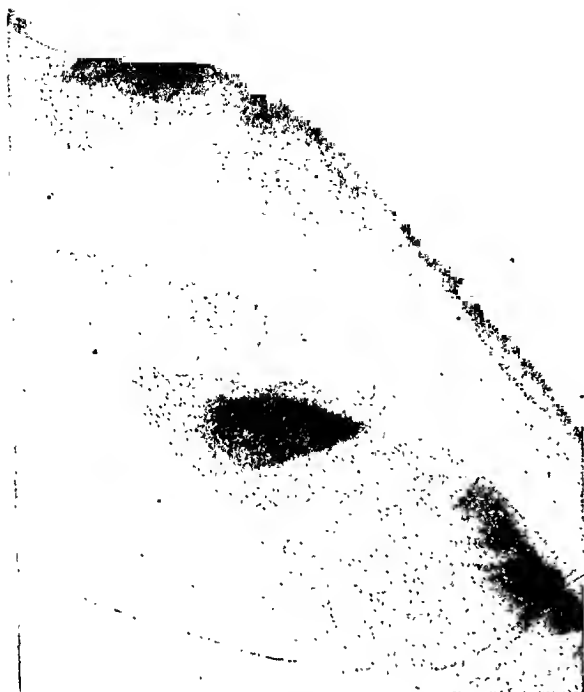
FIG. 1. Tumor of manubrium and upper part of sternum.

FIG. 2. Showing extreme vascularity of tumor.

polyhedral to spindle shape. A few scattered multinucleated tumor cells were identified. The cells had abundant clear cytoplasm and the nuclei were oval to round but relatively small. Mitotic figures were numerous. The cells were arranged in alveolated masses. The extreme vascularity of the tissue was a prominent feature of the tumor. A diagnosis of hemangioendothelioma was made. (Fig. 2.)

The patient was referred to a radiologist in February, 1945. X-ray treatments were given over the affected area from February 17 to March 23, 1945, for a total of 8,000 r. Following this there was a great deal of regression of the tumor mass. In April, 1945, radium treatment was given, the needles being implanted in some of the remaining thickened portion of the chest wall in the area of the tumor for a total of 900 mg. hours. The radiation reaction subsided and no tumor mass was palpable until September, 1945, when examination showed recurrence of firm induration. In October the tumor area seemed to show some increased fullness and roentgen examination revealed that the manubrium sterni and possibly the upper portion of the body of the sternum was involved.

The general condition of the patient was such that surgical excision of the tumor mass was considered. From October 22 until November

5, 1945, he was under observation and was being prepared for surgery. The thyroid, prostate and kidneys showed no abnormalities; heart and lungs were normal. No metastases were found and the Wassermann test was negative. The blood phosphatase and other laboratory findings were normal. Underneath the scar of the biopsy incision there was a hard, bony swelling, apparently belonging to the manubrium and upper part of the body of the sternum. The skin over it was dusky red and adherent to the underlying bone. There was no fluctuation of the mass and no palpable enlargement of the axillary or supraclavicular lymph nodes. On November 6th a partial resection of the sternum was done under general anesthesia with the intratracheal closed system.

Incision was made through skin and subcutaneous fat from the middle of the left sternocleidomastoid muscle to the xiphoid process over the left margin of the sternum. The skin flap was developed laterally and the fascia was incised. The sternal attachment of the sternocleidomastoid muscle was severed and the right sternoclavicular joint was disarticulated by sharp dissection. The periosteum of the first rib was then incised longitudinally, stripped with an elevator and the rib was severed close to the
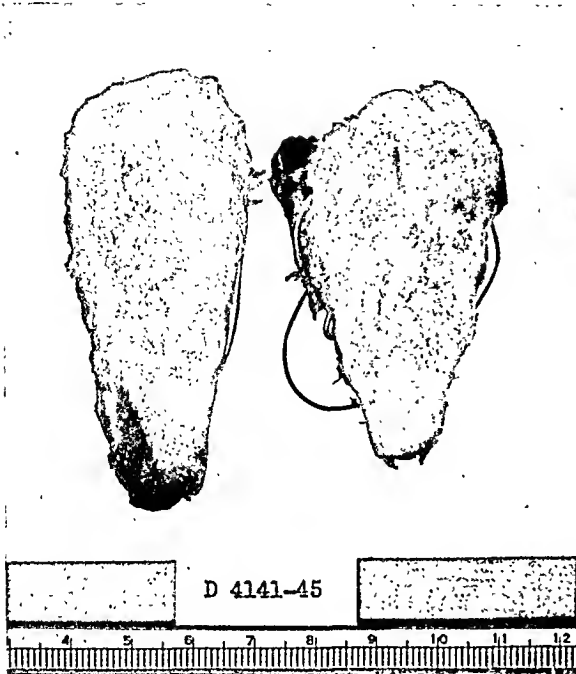
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FIG. 3. Section showing marrow space considerably expanded.

FIG. 4. Specimen showing greatly enlarged marrow spaces with no hematopoietic or tumor tissue visible.

cartilage. This procedure was repeated for the second and third ribs. The retrosternal space was then entered with the finger, the parietal
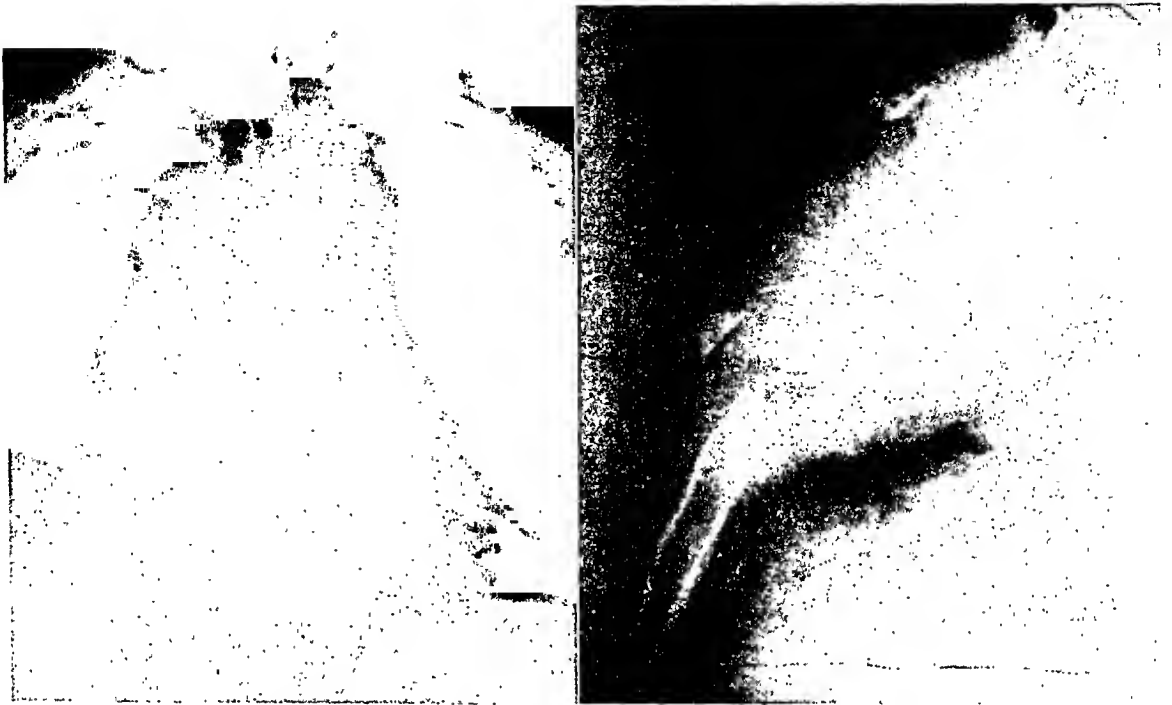

FIG. 5. Patient on tenth postoperative day.

pleura was carefully stripped and the anterior mediastinum was freed. The left sternoclavicular joint and the three ribs on the left side were then severed, applying the same procedure used for the right side. The body of the sternum was severed step by step with a small Luer, the whole bony structure easily being stripped from its attachments to the pleura and to the anterior mediastinum and removed. At this point all the anatomic structures, including a persistent thymus, could be seen uninjured. Both lungs were freely expanding under the pleura and no pathologic changes were noted. There was almost no bleeding from the bone and a few soft tissue bleeders were ligated with plain No. 00 catgut. The sternal end of the sternocleidomastoid muscle was attached with a few interrupted chromic No. 0 catgut sutures to the periosteum of the clavicle. The major pectoral muscles were mobilized and approximated with chromic No. 0 catgut as far as possible, leaving a defect 5 cm. by 5 cm. Subcutaneous tissues and skin were closed over the defect with No. 1 silk and two dermal retention sutures. The patient's postoperative condition was excellent.

Pathologically, the mass included the manubrium, part of the body of the sternum and a small portion of adjacent costal cartilages. The entire mass measured 12 cm. in width, 6.5 cm. in length and 3 cm. in thickness. The thickest area was situated in the upper left quadrant near the manubrioclavicular joint. On section the marrow space was considerably expanded.

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FIG. 8. Showing metastases in the skull.

(Fig. 3.) It occupied an area 4 cm. in transverse diameter and 2 cm. in thickness. The area was filled with semitranslucent, gray tissue. There was no gross evidence of tumor in the specimen. A small piece of pale skeletal muscle accompanied the specimen. Examination of the histologic preparations of the manubrium revealed greatly enlarged marrow spaces with only a few fragments of the bone lamellae remaining.

Areolar tissue and a small amount of adipose tissue filled the marrow spaces, except for some cystic defects. No hematopoietic or tumor tissue could be identified. (Fig. 4.) The cortex of the bone was of variable thickness with some newly formed bone and a small amount of cartilage at the periphery. The compact bone was poorly preserved, somewhat vacuolated and the osteocytes were distorted. The sections

Fig. 9. Showing destruction of the proximal end of the left humerus by metastatic growth.

of skeletal muscle showed large areas of atrophy, necrosis and formation of pseudomultinucleated giant cells, apparently produced by coalescence of nuclei following degeneration of the muscle fibers. Extensive regional fibrosis and slight lymphocytic infiltration was also noted.

The postoperative course was uneventful. On the fourth day the patient was able to sit up in bed and move his arms freely. On the fifth day he sat up in a chair. The wound was clean; there was no edema. The skin sutures were removed on the seventh day and the wound healed *per primam*. There was no shortness of breath. On the tenth day the patient was up and around, moving his arms and feeling well. (Fig. 5.) He was discharged from the hospital on the eleventh day and was seen at frequent intervals thereafter. He was able to come to the office and take a daily walk and had no shortness of breath.

Roentgenograms were taken before the patient left the hospital (Figs. 6 and 7) and showed marked bilateral enlargement of the upper portion of the mediastinum which was interpreted as most likely being due to blood collected in the anterior mediastinal space posteriorly.

A roentgenologic recheck was done on February 15, 1946, at which time there was no evidence of recurrence nor metastasis. In March, 1946, the patient developed a swelling of the left shoulder and several hard lumps appeared on the forehead and in both parietal regions. Biopsy of a nodule from the forehead revealed histologic similarity to that of the specimen previously removed from the manubrium. The roentgenogram of the skull revealed extensive bone destruction. (Fig. 8.) The proximal end of the left humerus was almost completely destroyed and the distal end also showed destruction. (Fig. 9.) The patient received x-ray treatment over the affected areas which relieved the pain in the left shoulder.

Development of metastases was sudden and progress was rapid. The patient died within three months after the onset of metastases. However, no local recurrence had developed.

COMMENTS

From the pathologic standpoint there appears to be considerable controversy regarding the classification of this type of tumor. In the differential diagnosis only types of non-bone forming tumors must be considered, such as Ewing's sarcoma and myeloma. In the case presented here the various types of myeloma are excluded on the basis of cytologic detail.

The term endothelioma of bone was introduced by Golgi in 1869 and served as a pigeon-hole for odd and unusual tumors, the origin of which was not clearly understood. Billroth (1856), Waldeyer (1878) and Kolaczek (1880) included cylindromas and angiosarcomas in this group. Some controversy ensued as to whether or not a non-osteogenic tumor of bone could exist. In 1924 Ewing presented histologic evidence in favor of such tumors and was supported in his contention by Conner (1926) and by Kolodny (1927). Some exception to Ewing's stand was raised by Ribbert and MacCallum.

The most striking features of Ewing's sarcoma (known also by the synonyms: hemangioendothelioma and hemangiosar-

coma) are its alveolated character, the presence of clear cells, the relative ease with which it is destroyed by x-ray and its dissemination to other bones after a latent period of some two months to three years from the time of discovery. The clinical course of our patient clearly resembles that of other cases of Ewing's sarcoma. It is notable that histologic examination of the sternum following x-ray treatment revealed a complete destruction of the tumor as far as could be ascertained. Changes secondary to x-ray were observed not only in the bone marrow but in the bone itself and in the surrounding skeletal muscle. It is noteworthy that the enlargement of the manubrium which developed subsequent to treatment was due not to the redevelopment of the tumor but rather to proliferative changes of the bone.

SUMMARY

A case of angiosarcoma of the sternum has been presented in which radiation therapy was followed by radical excision of the manubrium and upper part of the sternum. The patient made a rapid recovery from the operation without impairment of function. In spite of the radiosensitivity of the tumor the complete excision of the tumor mass and surrounding tissues and the apparent complete recovery of the patient after surgery, metastases occurred to the skull and left humerus, and death ensued within eighteen months from the onset of the symptoms.

A brief review of the literature and histologic diagnosis of angiosarcoma has been included.

CONCLUSIONS

1. This type of tumor is highly metastatic; and while the primary growth can be checked by radiation and surgery, the development of metastases cannot be prevented by present available methods of treatment.

2. Extensive resection of the chest bone can be done without functional impairment.

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MESENTERIC CYST

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THE infrequent occurrence, the difficulty in making a preoperative diagnosis and the problems encountered in the surgical treatment of mesenteric cysts make them a subject of great interest. In reviewing the literature I find that they are exceedingly rare. It has been said that one may terminate a long and successful surgical experience without having seen one such case. The first mention of this interesting condition is found in the writings of Benivieni, a Florentine anatomist of the sixteenth century. To the present there are only 500 collected reports in the literature.

The points of particular interest in a study of these cysts are their rarity, their origin and the infrequency with which they are recognized before operation. Portal in 1803 made the first attempt at classification. Since that time Rokitansky in 1842, Moynihan in 1897, Dowd in 1900 and many others have made suggestions which have contributed to the understanding of the origin of this condition.

Warfield in 1932 has compiled the most workable classification which is as follows: (1) Originating from retroperitoneal organs, namely, the germinal epithelium, ovary, Wolffian or Müllerian bodies. Remnants of these tissues are thought to be displaced between the leaves of the mesentery where they take up an independent and aberrant existence. Dermoid cyst, the rarest of all mesenteric tumors numbering less than twenty to date according to Pemberthy, have been found only in females, and this seems to give added support to the theory of embryonic origin. (2) Probably the next most tenable theory is that of displaced embryonal intestinal tissue. There is evidence to support the view of sequestration of intestinal diverticula or the vitelline duct (Meckle's) in the work of Lewis and Thyng (1908). They described the regular occurrence of diverticula in the embryos of the guinea pig, rabbit and man. Guthrie and Wakefield of the Mayo Clinic (1943) undertook a similar study to investigate the possible common origin and relationship between mesenteric and intestinal diverticula which occurs in the human and probably in the mammalian embryos. Their material consisted of embryos of guinea pigs ranging from 6 to 34 mm. in length and specimens from twenty-two human mesenteric cysts removed at operation. There were thirty-six guinea pig embryos studied and a total of seventy-six diverticula found. Histologic study revealed remnants of intestinal structures, epithelium and muscle bundles in the majority of twenty-two human specimens observed. It is in the realm of possibility that these diverticula continue to grow in the layers of the mesentery where they may or may not lose their continuity with the intestine. Wakefield has said that definite proof of the origin of mesenteric cyst from embryonic intestinal diverticula will come when someone is able to find a carcinoma developing in one of these cysts.

Other theories include: (3) Dermal inclusions as suggested by Bartlett in 1923. There are few supporters of this view. (4) Angiomas have been mentioned as a possible source. (5) Pseudocysts must be included. They may be of bacterial or infectious origin as hydatids, echinococcus and tuberculous nodes, or cystic degeneration of benign and malignant tumors. (6) Obstruction of lymph channels as a possible origin even of the chylous mesenteric cyst does not seem reasonable in view of the vast anastomosis existing in this system.

In the formation of mesenteric cysts

from an enterogenous origin it is thought that the mucous membrane is forced out through the fibers of the muscularis carrying the serosa with it to form a cavity outside of the lumen of the intestine. Finally, it is thought the connection with the lumen is obliterated and the cyst becomes isolated. In my first case, however, a very definite connection of the cyst with the anterior wall of the stomach was easily demonstrated. It was a tube about 0.25 to 0.5 cm. in diameter and approximately 1 cm. long and contained all of the layers of the stomach. In removing the cyst this attachment was ligated at the base and turned into the stomach by using a purse-string suture as is done in inverting an appendicel stump. I believe that this finding definitely proves diverticula of the intestinal tract as one source of origin of mesenteric cyst.

Mesenteric cysts have been found to occur more frequently in women than in men but elects no age group. They have been found in all ages from the fetus to eighty years. They are likely to be distributed along the course of the intestine from the duodenum to the rectum. About half have been found in the mesentery adjacent to the small bowel and one-fourth in the limits of the ileum.

Pathologically, the cysts are small to great in size varying from bare visibility to several centimeters in diameter. They may be single or multiple; approximately one-half are unilocular. The cyst wall may be very thin and fragile or at times rather thick. The lining is frequently columnar, stratified or occasionally ciliated epithelium. Muscle tissue similar to that found in the intestinal tract has been observed in the wall. Many of the cysts contain creamy, chylous fluid, clear liquid, coagulated material, gelatinous substance and all degrees of blood staining. The dermoid cysts contain hair follicles, sweat and mucous glands, fat, sebaceous material and all of the secondary skin elements.

The symptoms are largely dependent upon complications. The most frequently occurring are intestinal obstruction, torsion, impaction, rupture and intracystic hemorrhage. Obstruction may be ushered in with acute suddenness characterized by sharp, colicky abdominal pain, nausea, vomiting and obstipation. The general abdominal rigidity and tenderness often prevent the palpitation of the tumor and it is the exception when the true cause of the obstruction is understood before operation.

The diagnosis in the uncomplicated cases is notoriously difficult and in the presence of intestinal obstruction an accurate diagnosis is practically impossible. The knowledge of a previously existing intra-abdominal tumor may suggest the character of the obstruction with the onset of acute symptoms. Likewise, sudden, acute abdominal pain with unparalleled shock occurring in a patient with an abdominal tumor may be interpreted as hemorrhage into a cyst. Hastings of New Zealand reported such a case. The outstanding feature of the history and examination in the uncomplicated case is the presence of a movable mass in the abdomen which Moynihan thinks has greater range of mobility in the transverse direction. An abdominal tumor, however, offers many snares in the differential diagnosis. The more frequently occurring abdominal tumors are ovarian cyst, pedunculated fibroids, hydropic gallbladders, cyst or tumors of the kidney, neoplasms of the gastrointestinal tract and pancreatic cysts. There are adequate means of investigation to eliminate many of these lesions. Special x-ray studies with media apply in certain of the conditions. Ball believes that in many of the cases the mesenteric cyst will disarrange the normal intestinal relationship to be of significant diagnostic value.

Treatment is almost invariably surgical, but the exact procedure will be determined by the operative findings, general condition of the patient, size and position of the cyst and the associated complications. Intestinal obstruction, peritonitis, hemorrhage into the cyst, rupture into the

bowel, torsion of the cyst with gangrene and infection and impaction of the cyst in the pelvis are the most frequently found complications. Aspiration, marsupialization, incision and drainage, enucleation or resection of the cyst and adjacent bowel are the usual surgical procedures performed. Enucleation is the procedure of choice. Marsupialization and drainage remain very useful when removal is too dangerous. Removal of the cyst with bowel resection is necessary in from one-fourth to one-third of the cases for the relief of obstruction and acute peritonitis. Warfield reviewed the literature from 1920 to 1932 which comprised 129 cases. In this study the mortality from enucleation was 9 per cent, from enucleation with intestinal resection 27.3 per cent, from drainage and marsupialization 16.6 per cent. The following cases represent my experience:

CASE I. A white, single woman, twenty-eight years of age, was first seen November 8, 1944. Six months before she had had recurring spells of sharp pain across the upper abdomen lasting about an hour with associated bloating, and often vomiting, but no belching, heartburn, sour stomach or jaundice. The spells bore no relation to the time of eating or the type of food. On several occasions there was residual soreness in the upper abdomen for a week. Her present illness started three months before admission. On the occasion of her brother returning from the Army, she ran out on the porch to greet him and met him on the top step. Her impetus from running was so great that she knocked her brother over and together they rolled down four or five steps. At the time she noted minor abrasions of the face and knees but was none the worse for her tumble. Three to four hours later she experienced several fainting spells and retired to her bed where she remained until the next day. About ten days after the fall she noticed that her abdomen was increasing rather rapidly in size and was moderately sore throughout. As time went on the swelling became very marked and interfered with her breathing.

The outstanding findings in this 5 feet, 2 inch, 115 pound woman, when examined six weeks after the onset of her trouble, were marked pallor and a greatly distended abdomen. Her breathing was shallow and of an increased rate. There was dullness in both lung bases from the tenth rib downward. The abdomen was so swollen that the skin was tight and glistening. On percussion a fluid wave was easily demonstrated. No masses could be felt. Vaginal and rectal examinations were essentially negative. The extremities were free from edema. The initial erythrocyte count was 3,000,000. Hemoglobin was 36 per cent; leukocyte count, 7,500 with 70 per cent polymorphonuclears, 30 per cent lymphs and 9 per cent stabs. The urinalysis was negative.

The patient was given two transfusions of 500 cc. each of blood and operated upon the fourth day after admission. An upper right rectus incision was made. As soon as the peritoneum was incised there was a forceful gush of straw-colored fluid which rapidly became bloody. Two and one-half gallons were removed and a large irregular, polycystic tumor 15 by 8 cm. in diameter came into view. The color of the whole mass was reddish purple. It appeared to arise from and be incorporated in the anterior layer of the greater omentum. There was one stalk-like connection about 0.5 cm. in diameter and 1 cm. long with the anterior wall of the mid-portion of the stomach. It had the same appearance of the stomach. All vessels were clamped and ligated and the connection with the stomach was treated like an appendiceal stump by ligation and inversion. When the tumor had been removed and the fluid evacuated from the peritoneal cavity, a thorough exploration was done. The kidneys, gallbladder, liver and pelvic viscera were found to be normal. During the operation the patient received a transfusion of 500 cc. of blood and 1,000 cc. of saline. Her immediate postoperative condition was good, her convalescence was uneventful and she was dismissed from the hospital on her thirteenth postoperative day.

The pathologic report was made by Dr. Maxwell. The specimen consisted of a large nodular mass measuring 15 by 8 cm. The mass was lobulated and cut with little resistance. Sections through the tissue showed friable material with a number of small cystic spaces throughout. The sections showed numerous spaces which measured up to large cysts. Some were filled with blood; however, most of them were filled with granular coagulated

material. The cells were spindle shaped with hyperchromatic nuclei.

Diagnosis: Large lymph angio-endothelioma of the mesentery.

CASE II. The patient was a married, colored female, forty-six years old, who for one year had noticed a mass in the upper left quadrant of her abdomen which had increased rapidly in size within the last three months and caused some localized pain. History of systems was essentially negative. Examination showed a well nourished colored female, about 5 feet, 6 inches tall, weighing 160 pounds without evidence of weight loss. The essential finding was a tumor about the size of a grapefruit in the upper left abdomen which could be moved slightly in the transverse direction. The erythrocyte count was 4,100,000; hemoglobin, 80 per cent; leukocyte count 7,750 with 65 per cent polymorphonuclears, 35 per cent lymphs and 6 per cent stabs. The urinalysis was negative. An intravenous urogram was negative. Since there were no gastrointestinal symptoms a gastrointestinal x-ray series was not done. The preoperative diagnosis was pedunculated ovarian cyst or mesenteric cyst.

Exploration was done October 15, 1945, through a low mid-line incision which was extended upward. The uterus, tubes, ovaries and appendix were not unusual. There was a large mass the size of a honey dew melon in the upper left quadrant of the abdomen lying beneath the layers of the greater omentum. The stomach was displaced upward and the transverse colon downward to the rim of the pelvis by the mass. The cyst was apparently in the greater omental cavity being firmly adherent to the omentum anteriorly, the posterior surface of the stomach above and the mesocolon and transverse colon posteriorly. There were many large vessels coursing on the surface of the cyst. After considerable dissection had been done and the cyst freed, it was inadvertently opened. Thick, gelatinous, mucoid material was evacuated and the greater part of the cyst was removed. A routine appendectomy was done. The abdomen was then closed without drains. The convalescence was uneventful and the patient was dismissed on the thirteenth postoperative day.

The gross specimen was described as a large, irregular mass from the mesentery weighing 285 Gm. There was a number of small clear cysts in the larger mass. Histologically, the sections showed some of the cyst to be lined with low columnar cells in which the nuclei were near the attached surface. Other cysts were without an epithelial lining. The cystic spaces were filled with mucoid material and in the stroma there was a moderate lymphoid and plasma cell infiltration.

Diagnosis: Large pseudomucinous mesenteric cyst.*

SUMMARY

1. Mesenteric cysts are among the unusual abdominal tumors.

2. The etiology is unsettled but sequestration of germinal structures and intestinal diverticula are possible sources of origin and have good supportive evidence.

3. Symptoms usually are due to complications. The diagnosis is not accurate particularly with associated intestinal obstruction.

4. The treatment is surgical and the type of procedure depends on the finding and complications.

5. Two cases successfully operated upon are presented.

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* The second case recurred and the patient was operated upon by my friend, Dr. Howard Dorton, who gave me a report of his findings. The cyst had again attained large portions. He was able to define a definite tubular connection with the colon. This is similar to my findings in my first case, and again emphasizes intestinal diverticula as one of the possible origins.

ENTERIC INTUSSUSCEPTION IN THE ADULT

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INTUSSUSCEPTION in the adult is not only a most interesting and perplexing problem but it occurs very infrequently. Finding this condition in an adult brother and sister seems to be most unusual and worth reporting.

Enteric intussusception in the adult is encountered very rarely by the average surgeon. Both cases reported here were enteric intussusceptions and both apparently had the same etiologic factors.

A study made by Jason in 1945[1] shows that the incidence of intussusception in adults is about 5 per cent. According to Davis,[2] a study made in 1936 showed that of an all-time total admission of 113,351 in two large hospitals in Duluth, Minnesota, intussusception was found in twenty-two instances. Of these, only one was in an adult.

In the Beth-El Hospital in New York City, of 62,632 patients admitted in eleven years, a total of six cases of intussusception were found, one of which was in an adult.

At the Massachusetts General Hospital, of a total of 529,897 hospital admissions from 1887 to 1946, there were 146 cases of intussusception. Of these, sixty-four were in children and forty-three in adults; no age was recorded in thirty-nine cases.

At the Clover Hill Hospital, of a total of 26,178 patients admitted, there have been four cases of intussusception, one in a child and three in adults. All four were operated upon by the writer; two cases are reported herein.

Intussusception means the invagination of one part of the intestine into an adjacent part and its manner of growth is best described by the following quotation:[3]

"The growth of an intussusception occurs exclusively at the neck. The apex of the intussusception soon becomes edematous, stiff, and swollen, and once this has happened, it is impossible for the apex to change. The driving force is supplied entirely by the ensheathing layer or intussuscipiens. As in normal peristalsis, the circular fibers of the sheath contract strongly above, driving the intussusception on and forming a fixed point from which the longitudinal fibers can act. These act in one of two ways. If the sheath is loose, they pull it over the intussusception like a sleeve. If it is tight, they drive the intussusception into it. This is the only way an intussusception can grow."

TYPES OF INTUSSUSCEPTION

Four forms of intussusception are: (1) ileocecal, the most common, in which the ileum invaginates into the cecum at the ileocecal valve; (2) ileocolic, in which the small bowel intussuscepts into the large bowel; (3) enteric, in which the small intestine invaginates into the small intestine; (4) colic, in which the colon invaginates into itself.

ETIOLOGY

In infants, there are no real etiologic factors. In adults the following may be listed as some of the most common causes: (1) malignant or benign intestinal tumors; (2) polypi; (3) tubercular or typhoid ulcers; (4) appendicitis or Meckel's diverticulum; (5) congenital tumors; (6) rapid loss of weight; (7) submucous lipoma of ileum; (8) obstipation.

It is generally believed that intussusception is caused by irregular and increased peristalsis due to some irritant or lesion in the wall or lumen of the bowel.

Choffin Nason and Slenons[4] reported a case of intussusception during pregnancy and also listed twenty other cases of

intussusception during pregnancy reported from 1870 to 1934. Most of the mothers died and the causative agent in most of the cases was tuberculosis. In about one-half of the cases described in the literature no definite inciting cause appeared.

The first reported case of abdominal section for intussusception was by Hutchinson in 1871.[5]

SYMPTOMS

Symptoms are vague and atypical in most cases but the accepted signs and symptoms of intussusception are as follows: (1) intermittent colic-like pain anywhere in the abdomen; (2) nausea and vomiting; (3) obstipation; (4) blood or mucus in the stools; (5) mass or tumor in the abdomen not commonly palpable (but may be under anesthesia) which becomes increasingly larger as the condition progresses; (6) distention and rigidity as obstruction progresses; (7) tenderness over the involved area.

DIAGNOSIS

Careful evaluation of the history and physical findings is important. With the exception of the enteric type, x-ray examination with barium in rectum and colon usually gives invaluable information. Blood in the stool is a late manifestation in the enteric type of intussusception. Tumors in this type are small and hard to palpate. Bleeding is uncommon unless the intussusception persists for a long period of time.

Presence of a tumor that hardens during pains and relaxes in the free intervals is very helpful in reaching a diagnosis. Differentiation between intussusception and mesenteric thrombosis or embolism is most difficult at times although bloody stools and mucus are rare in these conditions. In intussusception blood or mucus is not mixed with stool nor does it have a fecal odor as in enteric colitis. The enteric type of intussusception is the most difficult to diagnose and one must always consider this condition in the process of differential diagnosis. Rectal examination is most helpful in many cases. Mesenteric thrombosis or embolism must always be considered because of its similarity in the clinical picture. This is especially true in adults. A tumor is rare in these cases while it is not uncommon in intussusception.
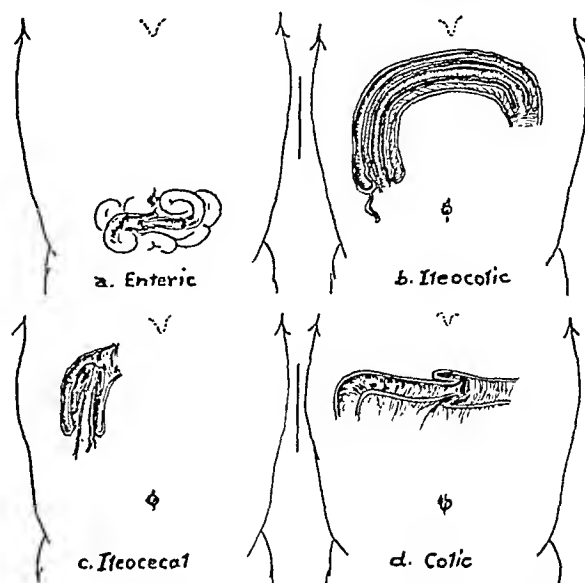
FIG. 1. Shows various types of intussusception. (From *Radiology*, 17: 60, 1931.)

TREATMENT

Intussusception is a surgical disease and surgery is usually the only treatment. Intussusception may be reduced at times by simply giving an enema. A barium enema under fluoroscopy should be given to see whether the simple enema has worked. This form of treatment may be risky and one should watch the patient carefully and be ready to operate immediately because instead of reducing itself, the condition may get worse, edema may become extensive and the intra-abdominal reduction may become much more difficult.

First, take care of the immediate emergency and second, eradicate the causes which brought about the intussusception. A plication of the mesentery may be done to prevent recurrence.

Excessive mobility of the sigmoid is overcome at times by stitching one of the longitudinal muscle striae for a few inches to the fascia of the psoas muscle as it

comes downward over the brim of the pelvis.

Primary resection and anastamosis may be necessary as in one of the cases reported herein. Wangensteen discusses several others. It must be remembered, however, that simple reduction by gentle traction gives a much better chance of success with less risk than resection. Wangensteen's[6] treatment of intussusception covers this phase of the subject with clarity and exactness. Of course, the causative agent, such as a tumor or polyp, must always be taken care of after reduction of the invagination. Croce and Wiper[7] in their reported case fixed the ascending colon and cecum to the lateral gutter with a series of sutures to prevent recurrence.

CASE REPORTS

The two patients mentioned herein are a brother and sister who had enteric intussusception, one occuring eight months after the other. The brother was twenty years of age and the sister was thirty-three years old.

CASE I. F. L., a white female, was a housewife who gave a history of having been ill when ten years old with "rheumatism" for three months. Her mother was told by the doctor that she would be left with a weak heart. She did not recall having been ill since that time until four years before admission when she became pregnant and had to be hospitalized because of a definite rheumatic heart. After considerable difficulty and treatment she went to term and delivered normal twins without incidence. Two year later she became pregnant again and had a stormy cardiac prenatal course. She went to term, however, and delivered a normal baby boy without incidence.

At about 3 A.M. on March 20, 1941, she was seized with acute abdominal pain which was more severe in the right lower quadrant. She vomited twice and the pain increased in severity. She took several doses of baking soda and was given an enema but no relief followed. The family doctor was then called and he sent her into the hospital with a diagnosis of appendicitis.

When first seen at the hospital soon after admission, she was screaming with generalized abdominal pain. Her temperature was 97.4°F., pulse 124, respirations 20 and blood pressure 110/52. Her color was ashen with a slight cyanotic tinge. She was cold and in apparent shock. The heart was rapid and arhythmic. There was a loud, blowing systolic murmur in the mitral area. Abdominal examination revealed a palpable, painful, circumscribed mass in the right rectus region. There was not much muscle spasm but the mass was exquisitely tender to palpation. Rectal examination, although negative, was not satisfactory because of extreme abdominal tenderness. The urine was negative; blood count showed 4,390,000 red blood cells, 17,500 white blood cells, hemoglobin 60 per cent, polymorphonuclears 89 per cent, bands 2 per cent and lymphocytes 9 per cent. Scout films were not helpful.

The patient was given shock treatment and was operated upon about three hours after admission. The preoperative diagnosis was "Probable ovarian cyst with twisted pedicle, or ruptured appendix with abscess." The abdomen was entered through an incision made just to the right of the median line. A large amount of bloody serous fluid was found in the abdominal cavity. The uterus, tubes, ovaries and appendix were normal. There was a large, sausage-like coil of small intestine invaginated for a distance of 1½ feet into an adjacent section of small intestine. The intestine was extremely edematous and cyanotic. It was under great tension, especially at the point of invagination where the mesentery was drawn up with it. There were numerous caseated lymph glands in the mesentery. The intussusception was reduced with great difficulty. It soon became apparent that despite successful reduction of the intussusception, resection of a large segment of small bowel was imperative. This was done. The intestine removed was dark, hemorrhagic and almost gangrenous in places. A side-to-side anastamosis was carried out in the routine manner after the cut ends were closed. After the rest of the intestine and other organs were inspected, the abdomen was closed in layers with No. 1 chromic catgut. A cigarette drain was left in the pelvis for drainage. The patient was returned to bed with a pulse of 116. The pulse continued to be rapid for about a week and then levelled off at 90. Her postoperative

eourse otherwise was without incidenee. She began to have bowel movements on the eighth day. She was diseharged on the sixteenth postoperative day with the wound healed and apparently well.

Pathologic examination showed a necrotic mueosa with marked hemorrhagic infarction throughout. The patient has been well sinee.

CASE II. C. D. P., a white male, had an appendix operation five years previously. He had had "stomaeh" trouble for several years; his past history, otherwise, revealed nothing pertinent.

His present illness started at 8:30 A.M. on November 20, 1941, when he suddenly was seized with aeute, generalized, abdominal pain which was so severe that he eollapsed. He apparently went . into shock. He vomited a "greenish" substance several times. His eyes, ears, nose and throat were within normal limits. He had a loud mitral systolie murmur which was heard loudest at the apex. The lungs showed no abnormality. The entire abdomen was rigid and spastie; there were no visible or palpable abdominal masses. There was more spasticity and tenderness in the left lower abdomen. No hernias were found. The extremities showed no abnormality; rectal examination was negative. There was no diarrhea and no blood by rectum. The urine was negative. A blood count showed 4,500,000 red blood cells, 21,850 white blood eells, hemoglobin 80 per cent, polymorphonucleårs 71 per cent, bands 12 per eent and lymphoeytes 17 per eent. Flat X-ray showed no free air in the abdomen; otherwise, it was not very helpful.

The preoperative diagnosis was "Perforated peptic uleer, acute panereatitis, or possible intussuseeption."

The patient was operated upon less than one hour after admission. A right paramedian incision was made from the umbilicus to the symphysis pubis. Considerable serosanguineous fluid was found in the abdomen. About a foot of dark, cyanotic small intestine was teleseoped into the small intestine. Although there was considerable edema, the intussusception was easily reduced and a good, healthy color soon returned to the bowel after warm saline packs were applied. Careful investigation revealed no tumor, lymph glands or any other visible or palpable cause of the intussusception. All fluid was aspirated and the abdomen was closed in layers without drainage.

The patient's postoperative course was stormy. Postoperative distention was pronouneed and very distressing. Prostigmin was given with poor results. Morphine and dilaudid were helpful. His nausea and vomiting were soon relieved by a Wangensteen apparatus but his pulse continued to be rapid. Colonic irrigations were given for the distention with good results. The return fluid was bloody and later he began to pass oeeasional blood elots. On the fourth postoperative day he had a normal bowel movement with no blood and with exeellent gas results. His abdomen beeame flat and his eondition improved considerably although he eontinued to be extremely restless and nervous. His pulse stayed rapid. Supportive treatment in the form of intravenous fluids was given during all this time. On the eighth postoperative day he suddenly eviseerated. Intra-abdominal examination revealed a distended bowel but the findings otherwise were normal. The abdominal wall was resutured in layers with No. 1 and No. 2 chromic catgut. Three stay sutures were placed. The postoperative course was again stormy but within six days he began to show marked signs of improvement and he was discharged on the twenty-third day after admission much improved with the wound strong and well healed.

COMMENT AND SUMMARY

The first part of this paper is concerned with a short presentation of the general subject of intussusception in adults.

Unusual cases of adult brother and sister, both suffering with enteric intussusception, are presented. Definite preoperative diagnosis was impossible in both. No obvious etiologic factor for the intussusception was found in either case. Both had valvular heart disease and hemorrhagic infarcts which may have been the causative agents of the intussusception. Both had the same sudden, severe onset associated with intense pain and shock.

Early operation in the second case saved a resection although the patient's postoperative course which included eviseeration, was by far more stormy than the first case.

Can intussusception be hereditary or

familial? No such cases could be found in a careful review of the literature.

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It is well known that peptic ulcer patients can be handled more successfully if the excessive gastric juice secretion which occurs at night can be properly controlled. It is also known that complete severance of both vagi effectively diminishes gastric secretion and acidity. The vagi are parasympathetic and form part of the autonomic nervous system. In like manner, it is known that injections of tetra-ethyl ammonium chloride can produce a temporary chemical sympathectomy effectively through action on the autonomic ganglia. These facts prompted J. M. Ferrer to investigate the value of this drug on the control of nocturnal gastric secretion. In a small series of cases, with an occasional failure, he has succeeded in effectively controlling or preventing night gastric secretion and acidity in peptic ulcer patients, especially by giving this drug at four-hour intervals during the night, using a dosage equivalent to 20 mg. per Kg. of body weight. The method seems worthy of further trials. (*Richard A. Leonardo, M.D.*)

FRACTURE OF THE NECK OF FEMUR

AN INSTRUMENT TO FACILITATE THE INTRODUCTION OF THE SMITH-PETERSEN NAIL

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ONE of the greatest advances in the field of surgery in recent years is the development of internal fixation for fractures of the neck of the femur.

FIG. 1. Anteroposterior view of guide pin.

FIG. 2. Lateral (abduction technic) of guide pin.

The design of the three-flanged nail and the technic for its use by Smith-Petersen has added hundreds of years to the collective lives of old people who suffer this injury usually through falls during normal pursuits and in their own homes.

As simple as the operation is *per se* it is often beset by many pitfalls in the form of complications, since the entire procedure is more mechanical than surgical.

The complications most commonly encountered are splitting of the shaft of the femur, driving the guide pin into the pelvis, bending the guide pin, breaking the nail within the bone and "locking" of the nail on the guide pin by spicules of bone.

Recently I had an experience that I have not seen reported although I am sure others have had such an experience. The following case history illustrates the point at hand.

CASE REPORT

Mrs. M. M., age seventy-seven, was admitted to Good Samaritan Hospital on April 26, 1946, and referred to me for treatment of intracapsular fracture of the left femur. She was prepared for surgery in the usual manner and the operation performed under cyclopropane anesthesia. After satisfactory reduction, confirmed by anteroposterior and lateral x-rays, the operative field was prepared and draped and the customary incision over the

FIG. 3. Anteroposterior view of Smith-Petersen nail in unfavorable position.

trochanter was made. Land marks were determined and the guide pin inserted through the neck and into the head of the femur. X-ray films in the anteroposterior and lateral position revealed that the position of the pin was satisfactory, not quite as good in the lateral view as desired (Fig. 2) but good enough to insure the nail entering the head. (Fig. 1.) Thus far very little time had been consumed and we were encouraged by what now seemed to be a very smooth operation in a minimum of time.

The nail was threaded over the guide pin in the usual manner and driven home. Our jubilation was short-lived when the second set of x-rays taken to confirm position of the nail revealed that it was lying in the soft tissues proximal to the neck, and was fixed only to the base of the trochanter and a portion of the superior rim of the head. We had encountered an accident in which the nail had slid along the shaft of the bone before actually penetrating the hard, brittle cortex of the femur, carrying the guide pin with it for a sufficient distance to produce the displacement just mentioned. There was also alteration of the position in the lateral view equally as bad. The upward displacement alone made the operation a complete failure. (Fig. 3.) The nail and guide pin were removed and the apparent cause of failure was confirmed by the appearance of the shaft of the femur at the pin site.

A second guide pin was then directed into the neck and head and a nail driven over this by first breaking the outer cortex with a sharp chisel to fit the lower two flanges of the Smith-Petersen nail and guide them until the nail had
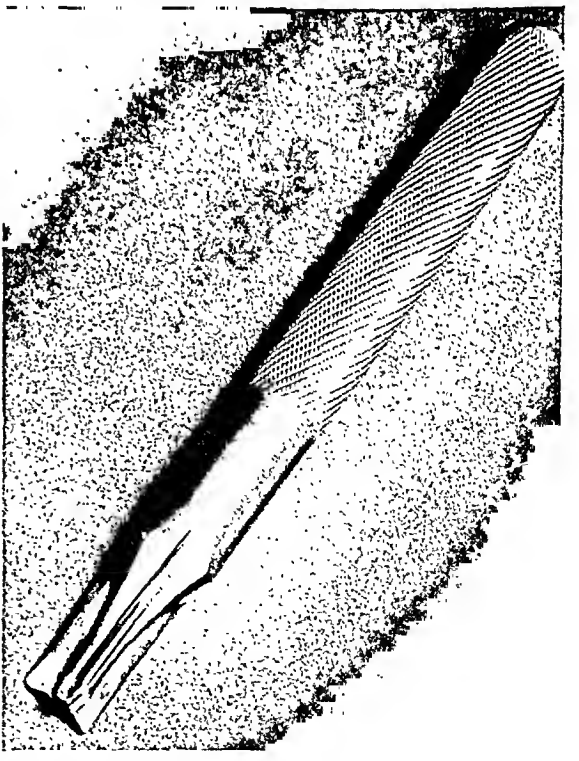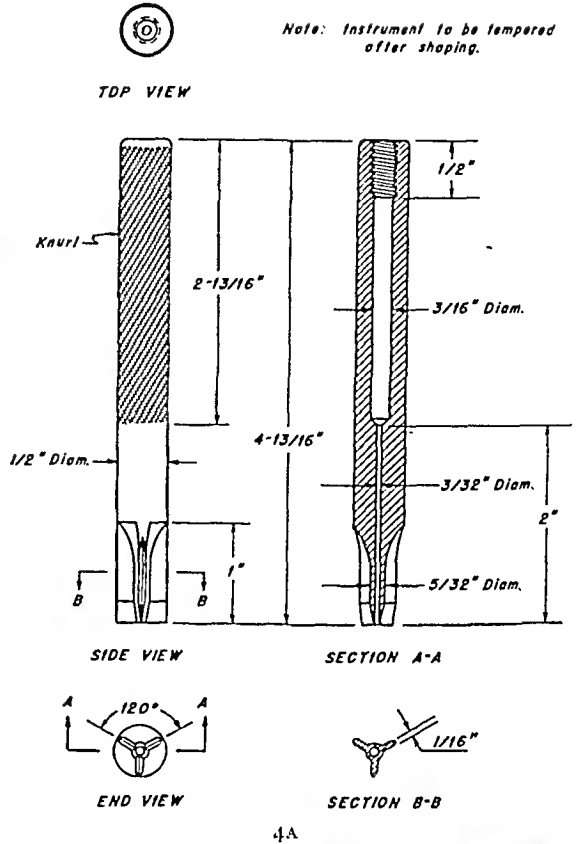
FIG. 4. A, specifications of starter; B, photograph of starter (actual size).

taken hold sufficiently to prevent a recurrence of the displacement. On this second attempt everything went smoothly and the nail was driven home in good position. The final end result was excellent. One year later the patient walked without crutch or cane and there was no shortening.

This experience inspired the writer to devise some means of overcoming this accident in ·future cases which, in my opinion, was due to two factors, namely, the extreme hardness and brittleness of bone in elderly people in the age group in which these fractures of the neck occur most frequently and the fact that the Smith-Petersen nails are actually quite dull comparatively speaking, and do not always engage the bone as easily as one might expect; which is also the reason for the shaft of the bone splitting not infrequently.

The result is an instrument imitating the Smith-Petersen nail in appearance made with a razor sharp edge on the three flanges, cannulated to fit over the guide pin and threaded at the upper end to receive the inserter in the same manner as the nail. The instrument is used only to make an impression in or through the outer cortex at time of operation. It is then removed and the nail applied in its place and driven home in the usual manner. It is made of drill-rod steel, sharpened and tempered, and can be made in any machine shop. Specifications and actual photograph are shown in Figures 4A and B.

I believe this simple instrument is a worth while addition to the equipment used in operations for fixation of the hip with the Smith-Petersen nail in that it is sharp instead of dull, assures the correct insertion of the nail and prevents accidents such as herein described. The factor of the edges being "razor-sharp" and the opposite end threaded for the inserter constitute the difference between this and the commercial starters, which are no sharper than the nail itself and for which a special "inserter" is recommended. These to my mind can be considered improvements. I have used it on numerous occasions since it was devised and am delighted with the performance and results. The additional time consumed is only the time necessary to remove the instrument and apply the nail in its place, a matter of a few seconds at the most.

The Early Art of Surgery

II. MORE OF THE "EBERS PAPYRUS"

Felix Cunha m.d.

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WHEN Rokitansky was one of the "Big Four" in medical stature in Vienna about sixty years ago, he gave the following advice to prospective students:

"Those of you who are about to study medicine, and to the younger physicians also, I say that you should light your torches at the fires of the Ancients."

It is my own wish that any reader of this series of articles will read not only the words but will try to see the man described, the man behind the words. It is also the writer's wish that the reader try to see the man's contemporary environment, how he by-passed the ignorance, prejudices, superstitions and religious codes which hemmed him in and, last but not least, the envy, greed and malicious persecution of his own confréres; it has ever and always been thus, that one of the greatest of all mankind's problems is man's inhumanity to man.

The Ebers Papyrus is presumed to have been written sometime in the vicinity of 1500 b.c. but much of the material in it came down by word of mouth from perhaps as much as five centuries before.

It is not strictly a book or manuscript, it is a miscellaneous collection of jottings down or experiences; some are prescriptions, some are advice on diagnosis, some are descriptions of postmortem appearances of things and, finally, some instructions are on what to do, and it is here that surgery comes in.

Curious indeed is much of the material contained in this papyrus. Apparently calculus of the bladder was a common affliction, arthritis of the joints another, but more curious still was the all too remarkable frequency of a fracture of the ulna about 2 inches above the wrist, and more commonly of the left ulna in women. Now the only explanation of such a fracture would be that the woman was defending herself from blows being swung by somebody else and took the blow on her arm instead of her head. Evidently husbands beat their wives three thousand years ago in the same fashion as today.

Then there is the description of how to splint this fracture using palm fiber as splint material and forming a tube-like, circular splint around the arm, drawing it tight with linen. The grotesque feature is that small slivers of palm fiber were stuck into bleeding areas in such a manner as to try to form an obstructive hemostasis.

Unfortunately in the Ebers Papyrus descriptions of actual technical procedures are missing, the usual term under treatment being "Thou shalt perform an operation," but how, it does not say.

Sutures and suturing are not mentioned. Hemostasis was apparently obtained by cauterization by means of red hot stones or sticks.

They did not try for "primary union," rather they interrupted normal healing in order to obtain a series of scars, each presumably tougher than the last.

In arteriovenous aneurysm they were smart enough to leave it alone. The instructions were "Thou shalt not put thy hand to such a thing."

In purulent affections of lymph nodes, particularly inguinal buboes, one waits

The Ebers Papyrus

until the proper degree of softness has arrived and then "Thou shalt hit the swelling into him."

Here we find perhaps the earliest of all descriptions of a hernia: "If thou examinist a swelling of the covering of a man's belly above the pudenda, then thou shalt place thy fingers on it and knock on thy fingers (percussion). If thou examinist that which has come out and has arisen by his coughing, then thou shalt say concerning it: it is a swelling of his belly—it is a disease which I will treat."

How? "Thou shalt heat it in order to shut it up in his belly."

They made quite a to-do about ascites and hydroceles but nothing as to paracentesis or tapping. The time is sixty-five hundred years ago and the art is young, young indeed.

S. A. Fox used preserved cartilage as an isograft in the reconstruction of eyelids and as a substitute for missing bone within and without the orbit. His results were very satisfactory and the procedure is not only simple but makes it unnecessary for the surgeon to remove cartilage from the patient's rib, ear or elsewhere. (*Richard A. Leonardo, M.D.*)

Editorials

TIME TO STREAMLINE MEDICAL PAPERS

AT a meeting of the Western Surgical Association held in St. Louis in December, 1948, the writer presented a paper on carcinoma of the thyroid gland. Thirteen minutes were devoted to the paper, including three minutes for the introduction. The latter had nothing to do with the problem but it is the basis for this brief editorial.

This was the introduction: "For years it was traditional never to give iodine to a patient having exophthalmic goiter, and it was always customary to drain in a case of ruptured appendicitis with peritonitis. Universally, patients were confined to their beds for one or more weeks following operation. Spinal anesthesia was considered a dangerous anesthetic to be used only in rare instances. Thousands of yards of gauze and adhesive tape were piled upon the patient's abdominal incisions in the hope of protecting the incision from contamination and of strengthening the wound." My entire thirteen minutes could have been devoted to discussion of traditional ideas in surgery whose abandonment years ago might have saved thousands of lives which were unnecessarily sacrificed to the gods of tradition. Tradition is the enemy of progress.

I believe we have come to a new era in medical writing. In this busy world we have little time to read long medical articles in the traditional style of 1748, 1848

or 1948. Instead we read the summary and if it interests us, we may turn back and review a few paragraphs and occasionally the entire article. My grandfather confined his journalistic reading to Lancet, Annals of Surgery and The Journal of the American Medical Association. Father added one or two more, and it was said of him that he could quote from memory the title, year, month and author of the most important articles on surgery. Today this entire page could be devoted to the names of the medical journals that come to our desks from all over the world. One must sort through a great quantity of chaff before he reaches the wheat. Although it is true that several journals are devoted largely to abstracts, even the review of these is time-consuming when time becomes more and more precious. Abstracts are only a "come on" and never satisfy me.

Much that appears in medical literature today has already been said not once but a hundred times or more. A friend of mine in Colorado said in reply to my question as to why he chose to live in the wide open spaces, "Because there is an awful lot of land where an awful lot of people that I don't like aint living." One might say that there are an awful lot of medical articles written about an awful lot of subjects that an awful lot of doctors have already covered. I plead guilty to this along with the rest.

Paper and labor are expensive and time and eyesight are more so. So my paper on cancer of the thyroid was condensed to ten minutes at St. Louis and, judging from the comments, it was far better received than if it had taken two or three times as long. In streamlining this article by first presenting my conclusions after the manner of the press and by amplifying the most important of these facts in the remaining minutes, I hoped to set a style in medical writing that would encourage others to abandon the traditional form of the past. No one is particularly interested in reading long historical reviews on the subject unless he expects to write along similar lines. One or two minutes for this phase is sufficient; so, too, for theories. Signs and symptoms can be appreciated and better remembered if tabulated; pathologic descriptions of a particular condition are important but can be condensed; surgical technic can be given with as few embelishments; photographs and drawings often speak better than words.

Most surgical journals, in fact, most medical journals have such a tremendous backlog of articles on hand that it will be months and perhaps years before some articles will appear. Many of these articles could be briefed and still be accurate and informative. Because time is moving so fast and advancement in medical progress is so rapid, some articles are almost out of date when they finally appear. Certain types of papers, particularly those dealing with research studies, cannot be placed under the subject of this editorial, yet some of these also might stand a little trimming.

That this new style of streamlined paper meets with approval may be judged from the comments of two surgeons who attended the meeting: Mr. Guy Blackburn of Guy's Hospital, London, wrote, "I enjoyed your paper more than any I heard at the two meetings. You condensed so much into so short a time that it would be an excellent thing if more people were encouraged to do likewise." Dr. H. H. Searls, San Francisco, said, "Your exposition of the material was a marvelous concentration, giving the most in the least time that I have ever heard." There was nothing unusual about the paper. It was liked simply because it was streamlined.

ARNOLD S. JACKSON, M.D.

Dr. Jackson offers medical authors a new way of writing scientific papers. It is obvious that all surgical manuscripts do not come under this category, but one confined to a new clinical point, a new surgical technic or a case history can well be "streamlined." Due to many factors beyond our control, a large backlog of papers are in our files. We are asking some authors to shorten their articles and others to streamline their manuscripts. In this way our backlog will get earlier publication. We hope to publish all accepted material in six to nine months' time. Therefore, we suggest, if you contemplate writing a scientific article, that you consider whether or not it can be streamlined. It might be well to reread and study Dr. Jackson's editorial and then practice this new technic. If we receive enough streamlined papers, we will devote a department to such communications. Should you wish further information on this matter, drop us a line.

EDITOR

IS THE WORD "SHOCK" ABSOLUTELY NECESSARY?

THE word "shock" connotes much that is unpleasant to the doctor. He may have been exposed and sensitized to it during medical school by having been asked the question, "What is shock and how do you treat it"? Later he may have observed a baby or an old man who needed an operation as a life-saving measure, but such help was withheld because it was presumed that the patient could "never stand the shock." Perhaps he was admonished not to apply pain-relieving dressings to a severely burned patient as a preliminary measure but rather to treat the "shock." No doubt he has seen patients returned to the wards from the operating room in a dying or near dying condition. "Shock" he was told. He may have seen individuals near death from infections of both the medical and surgical type. They were pulseless and covered with the cold sweat of the agonal period. "Shock!"

What is shock? Webster's Collegiate Dictionary gives six definitions. It is (1) the impact of individuals or groups in combat; (2) a blow, impact or collision or a violent shake or jar, also the effect of such violence as an earthquake shock; (3) a sudden agitation of the mental or emotional sensibilities or an event causing this; (4) (colloq.) a stroke of paralysis; (5) the sudden stimulation caused by the discharge through the animal system of electricity; and (6) (Med.) a state of profound depression of the vital processes resulting from wounds, hemorrhage, crushing injuries, blows, etc." Thus, the word has five distinct meanings before the medical definition is reached.

Some writers on the subject have tried to define shock; other have advised against the attempt. In his extensive review of the subject Harkins[1] lists a number of defini-

tions which have been proposed since the year 1826. Some examples: "A manifestation of a rude unhinging of the machinery of life" (Gross, 1872). "The reaction of the central nervous system to exaggerated or abnormal afferent impulses" (Gray and Parsons, 1912). "A condition of suddenly developing general damage" (Selye, Dosne, Bassett and Whittaker, 1940). Harkins himself proposed a brief definition stating that shock is "a progressive vasoconstrictive oligemic anoxia." For a descriptive definition, he offered: "An oligemia initiated by traumatic local fluid loss, either whole blood, plasma or both; accompanied by decreased cardiac output, diminished volume flow, lowered venous pressure, decreased oxygen consumption, arteriolar vasoconstriction, acapnia and secondary blood pressure fall; and perpetuated by a summation of these factors and possibly hyperpotassemia, increased generalized capillary permeability, anoxia, action of tissue metabolites and deficiency of adrenal cortical hormone."

In his book on the principles of surgical care Blalock[2] stated that most of the attempts that have been made to define shock have confused rather than clarified the subject. He mentioned that Cannon was of the opinion that definition was not a prime requisite in such a complex as shock, and that O'Shaugnessy and Slome had suggested that the difficulty in definition would be overcome by abandoning the attempt and providing instead a clinical picture of the syndrome.

This brings us to the question posed by this communication. Could we go a step further and not only abandon attempts to define the word but abandon it altogether?

Practice in doing without the word shock can be obtained by taking surgical texts and articles and marking out the offender,

[1] HARKINS, H. N. Recent advances in the study and management of traumatic shock. Surgery, 9: 231, 447, 607, 1941.

[2] BLALOCK, ALFRED. Principles of Surgical Care: Shock and Other Problems. St. Louis, 1940. C. V. Mosby.

substituting words more descriptive of the actual conditions. After becoming proficient, one can proceed to apply the new art in the writing of actual clinical histories and operating room notes.

The following sample sentences are supplied to encourage the beginner. In each instance the italicized words are to be replaced by the words in parentheses which follow: (1) The patient is admitted following a traumatic amputation of the leg, *in a state of shock* (with low blood pressure because of severe hemorrhage). (2) During the application of the traction apparatus for the fracture of the femur, the patient *went into shock* (developed a weak, fast pulse, probably due to local loss of blood about the fracture site or to undiagnosed extravascular collections of blood). (3) Following radical mastectomy, the patient was returned to her room in *profound shock* (poor condition due to inadequate blood replacement during the operation). (4) We will give this severely burned patient a liter of blood in order to *prevent burn shock* (maintain blood volume). (5) This patient has a board-like abdomen and *is in shock* (is in great pain and has a weak pulse). (6) For a minor operation, we gave the patient a spinal anesthetic and he immediately *went into shock* (showed an exaggerated vasodilator response as evidenced by the transient hypotension).

The indications for rational treatment in the six hypothetical cases given above are clearer if one uses the more explanatory phrases. Whole blood would be given to the first three, without wasting time with other measures. Blood or plasma would suffice for the fourth.— Morphine and an operation for perforated ulcer would probably correct the weak pulse in the fifth case. The adequate use of the vasoconstrictor drugs will prevent or remedy the hypotension associated with spinal anesthesia.

Is it possible that a dictionary of the year 2000 would contain the following "Shock: (obs.) medical term formerly used in connection with a number of pathologic states in which there was low blood pressure and other evidences of depression of the vital processes"?

CONRAD R. LAM, M.D.

Original Articles

THE VAGINA IN RECONSTRUCTIVE SURGERY*

A HISTOLOGIC STUDY OF ITS STRUCTURAL COMPONENTS

J. V. Ricci, m.d., J. R. Lisa, m.d., C. H. Thom, Jr., m.d. and W. Kron, m.d.

New York, New York

PLASTIC surgery for the correction of relaxations, lacerations, fistulous formations and descents of the urethro-vesico-ano-recto-genital parts necessitates in all instances an invasion of the vaginal wall. For this reason a thorough understanding of the histologic structure of this organ is essential.

A review of the literature dealing with this subject reveals a multitude of contradictory views. In 1886 J. Henle[1] described and depicted in a free-hand drawing the structural elements of the adult vagina, labelling the histologic components vaginal epithelium, submucosa, an inner layer of longitudinal muscle fibers and an outer layer of circular muscle fibers. H. Luschka[2] two years later (1868) reversed the order of the muscular layers. In 1871 M. Lowenstein[3] described gland-like crypts. and lymph follicles similar in structure to the solitary glands of the small intestines. A. Breisky[4] in 1887 reporting for himself, Eppinger and Toldt, after examination of a number of specimens, stated that the inner muscular layer was transversely arranged and the outer layer was longitudinally arranged. Breisky added that this pattern prevailed when the section fell exactly upon a columna, especially the anterior one, but he agreed with Eppinger and Toldt that the muscular layers conformed with the general muscular structure of the uterus. This view also explained in a more satisfactory manner the circular contractions of the vagina occasionally met with clinically.

Toldt had found an external dense layer of longitudinal fibers and an inner non-continuous layer in which the fibers were mostly circular with some longitudinal and oblique fibers. He also observed lymph-follicle bodies in the mucosa.[5]

According to F. von Preuschen[6] the deepest layers of the mucous membrane of the vagina contained cylindrical cells with elongated nuclei. In the crypts of the mucosa of the upper vagina were conglomerate glands lined with ciliated epithelium. Breisky stated that the above view was supported by Huckel and Heitzman. C. Ruge found a very distinct glandular structure on the inner surface of the hymen in a case of atresia hymenalis. A. C. Cowperthwaite,[7] in 1888, after microscopic and "sectional" examination reported that the mucous membrane was made up of epithelium (the superficial layer being squamous and nucleated; the deeper layer, cylindrical with elongated nuclei), connective tissue, elastic tissue and some unstriped muscle fiber. The superficial layer of connective tissue formed papillae into which blood vessels projected. External to this epithelial layer, lay two layers of unstriped muscular fibers; the inner longitudinal, the outer circular. Thus he agreed with Henle on the muscular arrangement and credited Breisky with the view that the inner layer of muscle was of circular arrangement.

A. Macalister[8] (1889) stated that the vagina consisted of a stratified scaly epi-

thelium, a dense corium with many papillae and glands, a vascular erectile lamina with many venous plexuses, a layer of unstriped circular muscle, a layer of longitudinal unstriped muscle and a dense outer areolar layer. Outside this was the striped sphincter vaginae, at the vulval end of the passage only, extending to but not beyond the triangular ligaments. In 1900 A. A. Bohm and M. von Davidoff[9] described the three coats of the vagina as mucous membrane, as muscular and outer fibrous covering. They stated that the mucosa of the vagina consisted of numerous connective tissue fibers mingled with coarse elastic fibers. Papillae containing blood vessels were everywhere except in the depressions between the columnae rugarum. They also stated that diffuse adenoid tissue which sometimes assumed the form of lymphatic nodules was present in the mucosa. The muscular coat which in the lower region was quite prominent was separated indistinctly into an outer longitudinal and inner circular layer; the latter was, as a rule, poorly developed and occasionally entirely absent. The muscular coat was especially well developed anteriorly in the neighborhood of the bladder. The outer fibrous layer consisted of dense connective tissue loosely connected with adjacent structures.

In 1900 E. K. Dunham[10] described the muscular coat of the vagina as not clearly divisible into layers though the inner fibers were chiefly circular and the outer longitudinal. He regarded the latter as the true muscular coat of the vagina. Outside the muscular coat was a layer of areolar tissue connecting the vagina with its neighboring parts except at its posterior and upper part where it was covered with a serous membrane forming part of the peritoneum. In 1905 D. B. Hart and A. H. F. Barbour[11] quoted Henle, Breisky, von Preuschen and Lowenstein but did not evaluate the different theories of these observers. In 1910 W. Blair Bell[12] stated that the vagina was surrounded by an investment of muscular and fascial off-shoots containing vessels. Within this was a coat of involuntary muscle fibers running for the most part longitudinally but in the lower part concentrically as well. He presented two photomicrographs of the vaginal wall but the component parts were not labelled. In 1925 F. R. Bailey[13] described the vagina as having four coats, which he labelled from the outside inward as the fibrous, muscular, submucous and mucous. The fibrous coat consisted of dense connective tissue with many coarse elastic fibers, connecting the vagina with the surrounding structures. The muscular coat was indistinctly divided into an outer longitudinal and an inner circular layer, the latter being usually poorly developed or even absent. The submucosa was a layer of loose connective tissue especially rich in elastic fibers and blood vessels. Numerous large venous channels gave to the submucosa the character of erectile tissue. The mucous membrane consisted of a papillated connective tissue stroma of mixed fibrous and elastic tissue. The stroma usually contained diffuse lymphoid tissue and more rarely solitary nodules. In 1934 E. V. Cowdry[14] stated that the tunica propria often contained an abundance of lymphocytes and even lymph nodules. He added that the smooth muscle fibers were mostly longitudinal but that striated muscle formed a kind of sphincter at the opening.

In 1931 H. S. and R. J. Crossen[15] described the vagina as having three layers: an external connective tissue layer, a middle muscular layer and an inner mucous layer. The connective tissue served to connect the vagina to the adjacent organs. The muscular layer contained involuntary muscle fibers arranged in bundles without distinct strata. Some of the bundles were longitudinal, some transverse and some oblique. The muscle layer was thicker at the lower than at the upper end. The mucosa was attached to the muscular coat by a submucous layer of loose connective tissue which was very rich in interlacing veins. Bundles of muscular fibers around
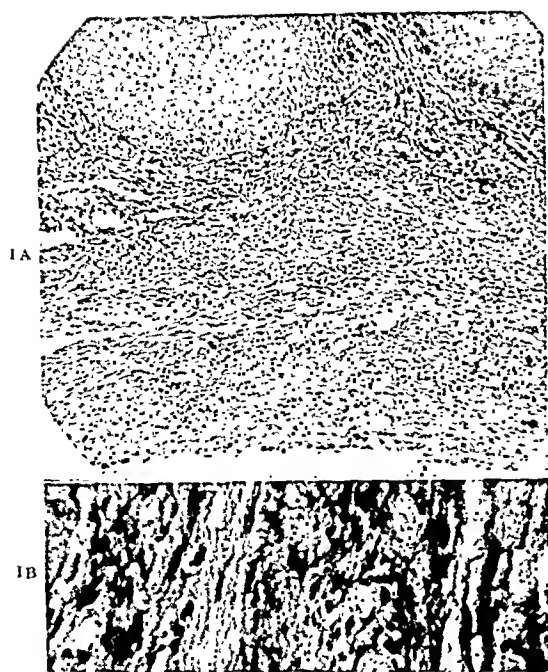
FIG. 1. Case I, four months' fetus. A, transverse section through the posterior vaginal wall at the middle third, showing squamous epithelium, vascular and fibrous substantia propria, the musculo-fibro-elastic layer and loose areolar tissue of the rectovaginal avascular space; elastic tissue stain × 135. B, a high power view of a similar area showing the three layers, epithelium, substantia propria and the musculo-fibro-elastic layer. In the substantia propria fibrous tissue, some elastic tissue and fairly prominent vessels are found. In the third layer there are some muscle fibers, fibrous tissue and elastic tissue which become more prominent in the outer portion where it encloses the nutrient vessels. The basal layer of vaginal epithelium is seen in the upper left hand corner; elastic tissue stain × 400.

FIG. 2. Case II, six months' fetus. A, a high power view of the clitoris demonstrating erectile tissue with a marked vascularity and the involuntary muscle strands lying between the vessels; H and E stain × 90. B, transverse section through the posterior fornix, showing the fibrous and well vascularized wall, the scant muscle in the outer portion and scant elastica carrying the blood vessels. At the left is a small segment of the vaginal squamous epithelium; H and E stain × 90. C, transverse section through the perineal body, showing close fibrous fusion between the vagina and the rectum, a lack of elastica in the third layer and fairly prominent muscle; H and E stain × 15.

some of these veins formed a sort of vascular tissue.

In 1946 E. Novak[16] divided the vaginal wall into three layers: an outer fibrous, a middle muscular and an inner mucous. The fibrous coat was derived from the pelvic fascia while the muscular coat consisted mainly of an inner circular and an outer longitudinal layer. He also stated that normally there were no glands found in the vagina but, on rare occasions, a few glands were found in the fornix, usually aberrant cervical glands or gland-like tubules derived from the vestigial Wolffian duct. In 1947 A. H. Curtis[17] stated that the wall of the vagina was made up of three principal coats: an outer fibrous, a middle muscular and an inner mucous. The outer fibrous layer with the pelvic fascial and extraperitoneal tissue formed a dense sheath which clothed the vagina and connected it with surrounding structures—the bladder, urethra, colon and pelvic diaphragm. The muscular coat consisted of somewhat irregularly arranged groups of involuntary muscle fibers among which a considerable amount of connective tissue was distributed. This arrangement rendered the transition to the outer fibrous coat a very gradual one in which sharp delineation was lacking. The fibers in the muscularis were arranged chiefly in an inner circular and an outer longitudinal arrangement. In the tunica propria solitary lymph nodules were occasionally found. The deeper portion of the areolar tissue layer was permeated by
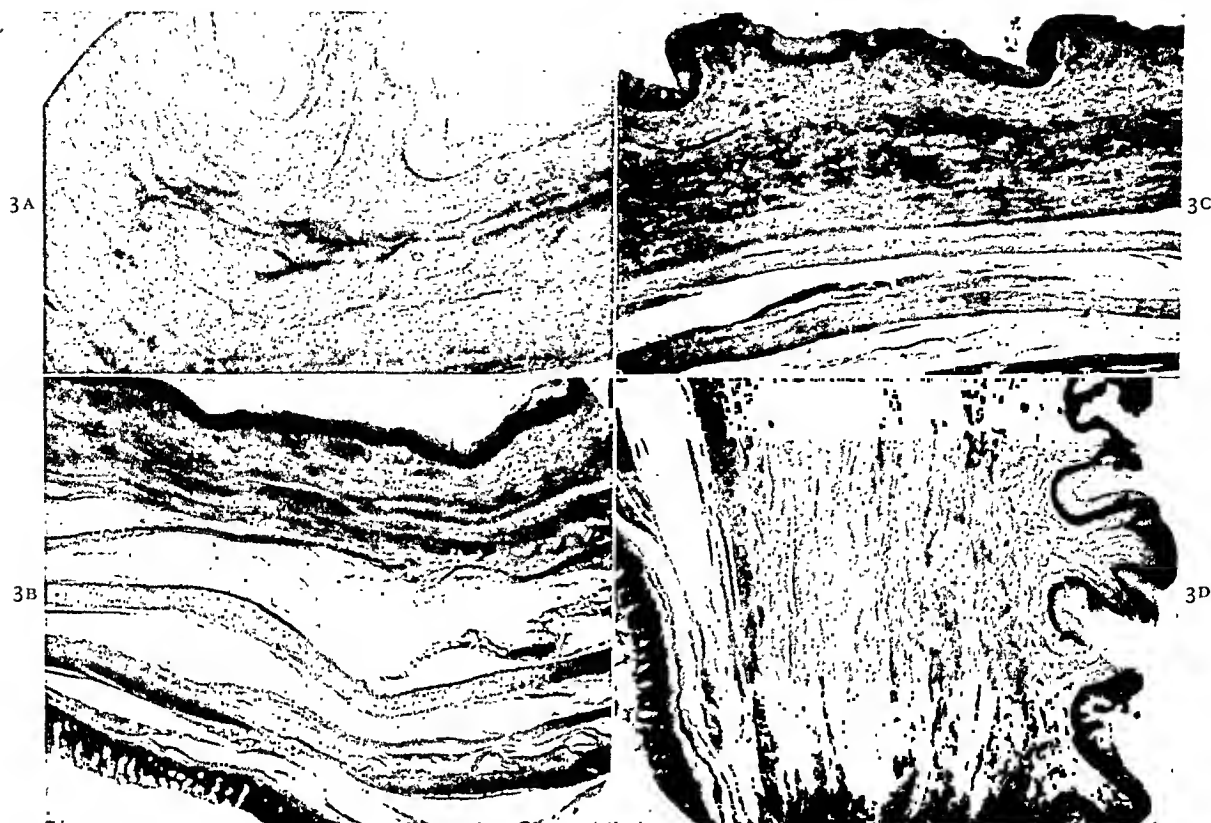
FIG. 3. Case VII, aged twenty years (three months' pregnancy). A, longitudinal section through the upper vaginal wall and anterior fornix showing the dense elastic component surrounding the vessels arising from the cardinal ligament and lying in the third layer of the vaginal wall. At this point there is partial fusion with the musculature components of the bladder in the trigonal region; elastic tissue stain × 30. B, longitudinal section through the posterior wall of the upper vagina below the fornix showing the compact vaginal wall and the elastic component around the vessels in the third layer. The rectal wall is loose in texture, the muscle layers being separated by wide areolar zones; H and E stain × 15; C, longitudinal section through middle portion of the posterior vaginal wall. In the vagina the elastica in the third layer is moderately prominent and the muscular component is scanty. The rectal wall is extremely thin and the muscle coats are separated by loose areolar tissue; H and E stain × 15; D, transverse section through the perineal body showing the close fusion between the two organs. The rectal mucosa is loosely attached by its sub-mucosa and muscular coats are completely fused with the vaginal wall; there is scanty elastica; H and E stain × 15.

a plexiform arrangement of vascular channels and contained scattered bundles of smooth muscle cells; hence it was described by some as a tela submucosa and by others as erectile tissue comparable to that found in the bulb of the vestibule.

In a previous communication[18] the general architecture of the vagina was presented in its relationships to the surrounding organs. The present communication deals with the detailed histologic anatomy of the vagina, with particular attention to its muscular and elastic components and their various anatomic arrangements at different levels. The influence of gravity was studied in one specimen. The present study was based on the microscopy of fourteen specimens, each consisting of the entire vagina from the cervicovaginal junction to and including the anoperineal body and the fused urethrovaginal wall. Of these specimens, six were removed from the cadavers of fetus and infants; the remaining eight specimens were removed from adult cadavers. Only cadavers presenting no pelvic disease were selected. One specimen was removed from the body of a twenty year old patient who was three months' pregnant. The tissues were placed in fixing fluids and embedded in paraffin and celloidin. Some specimens were subjected to serial cross sections, some to serial saggital sections and others to both. The tissues were stained with hematoxylin and
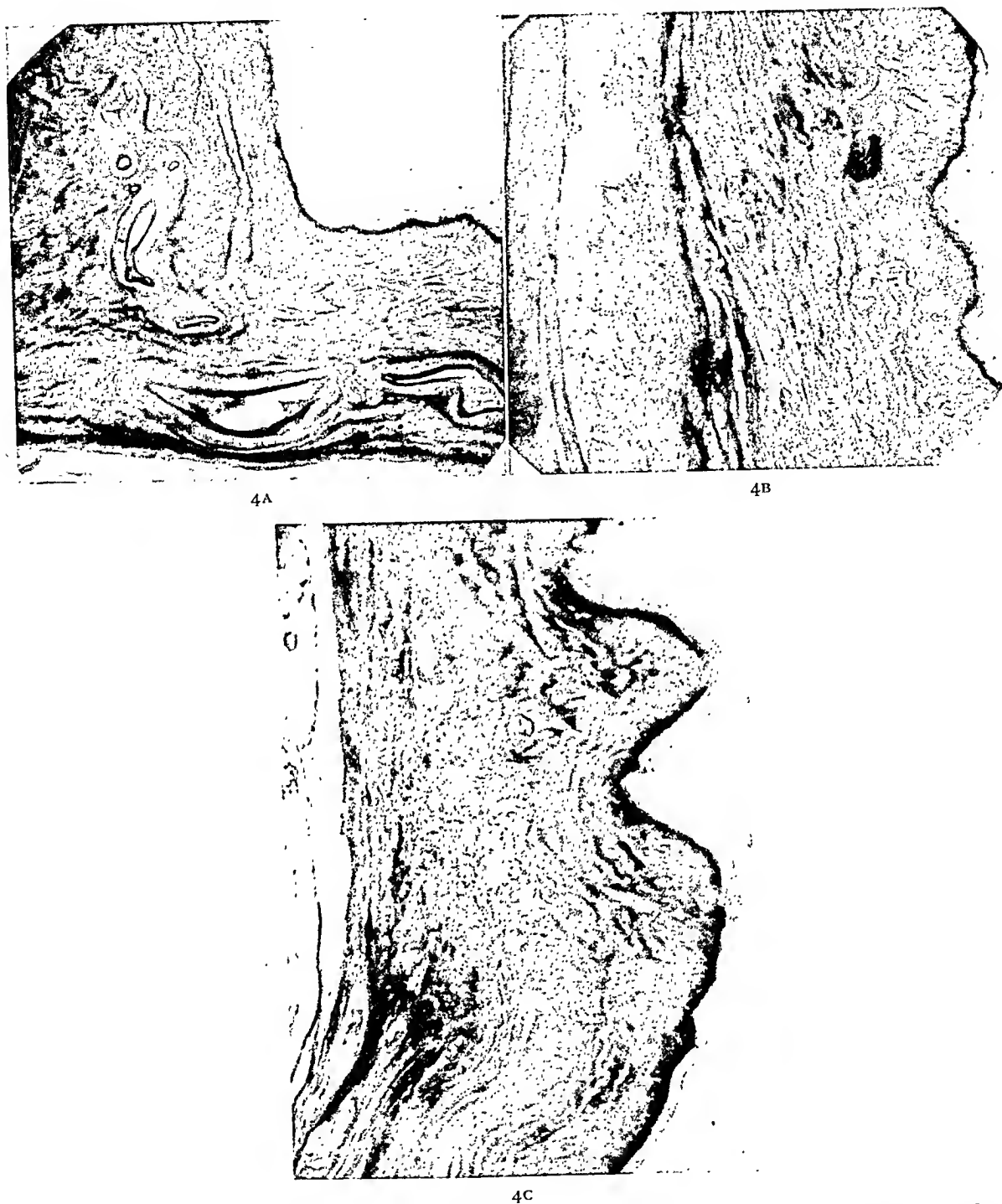
4A

4B

4C

FIG. 4. Case IX, aged forty-one years. A, longitudinal section through the anterior fornix showing the outer layer of compact elastica associated with the vessels coming down from the cardinal ligament; elastic tissue stain × 15. B, longitudinal section through the upper third of the anterior vaginal wall and bladder showing the compact elastic component of the outer portion of the third layer; elastic tissue stain × 15. C, longitudinal section through the upper third of the posterior vaginal wall showing the heavy elastic component of the third layer carrying blood vessels; elastic tissue stain × 15.

Fig. 5. Case xii, aged forty-three years. Longitudinal section through the cul-de-sac of Douglas showing the compound layer of elastica in the outer portion of the third layer which becomes scantier, more caudad. The peritoneum of the cul-de-sac is in the lower part of the picture, the vaginal mucosa in the upper. The upper portion of the section is on the right; elastic tissue stain × 15.

6A   6B
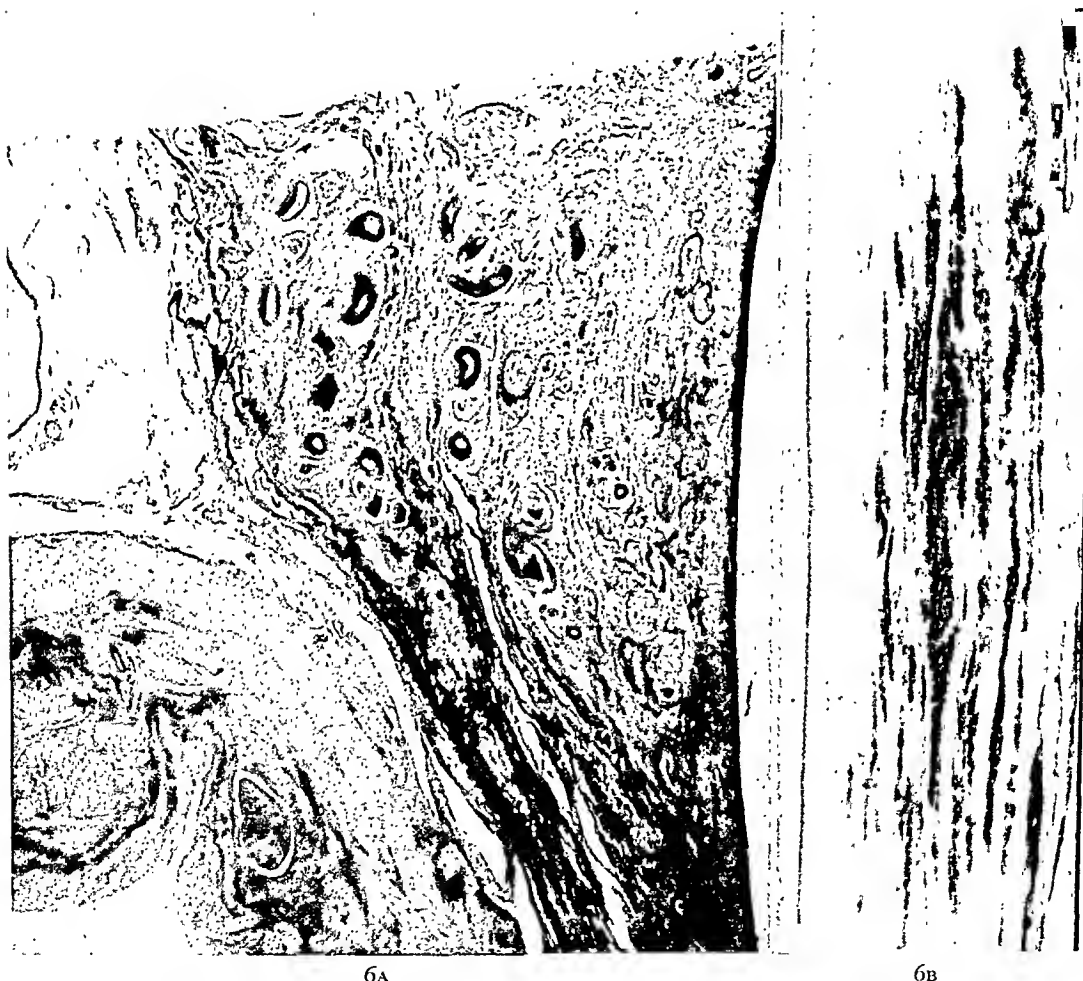
Fig. 6. Case xiii, aged sixty years. A, longitudinal section through the cardinal ligament, anterior fornix and bladder showing the close fusion of the cardinal ligament to the upper vaginal wall and the heavy elastic component which encloses the vessels sweeping down into the outer portion of the vaginal wall. The anterior peritoneal fold is included. The vaginal mucosa is flat and atrophic; elastic tissue stain × 6. b, longitudinal section through the middle portion of the posterior vaginal wall showing the atrophic mucosa and a compact wall consisting predominantly of elastica; elastic tissue stain × 30.

eosin, Verhoff's elastica stain and von Giesson's connective tissue stain. (Figs. 1 to 6.)

Results of this study show that the vaginal wall can be divided into three layers—the epithelium, the substantia propria and the musculo-fibro-elastic layer. The strati-

TABLE 1

Specimen	Age	Color	Parity
1	4 mo. fetus	White	
2	6 mo. fetus	White	
3	8 mo. fetus	White	
4	9 mo. fetus	White	
5	6 mo. infant	White	
6	12 mo. infant	White	
7	20 yr.	White	
8	31 yr.	Colored	Nullipara
9	41 yr.	White	Nullipara
10	42 yr.	Colored	Para VIII
11	42 yr.	Colored	?
12	43 yr.	White	Nullipara
13	60 yr.	White	Multipara
14	67 yr.	White	Multipara

fied squamous epithelium is similar in all ages. The vaginal wall lacks glands and lymphatic tissue. In the fetus and infant the rugae are large and prominent. They tend to become flattened in adult life and are almost completely obliterated in the senile period.

The substantia propria consists of a fibro-elastic network enclosing the arteries, veins and nerves. The elastica has both fine and coarse fibers. It is similar in architectural pattern at all ages and is free of intrinsic muscle fibers. In only one specimen (from the four months' fetus) were there a few involuntary muscle strands in the distal portion of the vaginal wall which were finger-like projections of the third vaginal layer. There is no suggestion of erectile tissue in the architectural pattern as has been described by other observers.

The third layer of the vagina is formed of the musculo-fibro-elastic tissue. It is a compact structure not separable into individual layers. Anteriorly, it is intimately fused with the urethra from the base of the bladder to the urethral meatus. Posteriorly, it is intimately fused with the anoperineal body and is separated from the rectal mus-

culature by areolar tissue. Occasionally fine elastic fibrils enter the loose areolar tissue from the outer surface of the vaginal wall. The fibrous component of the third layer is interwoven with the other two elements. Superiorly and inferiorly it forms the principal component where the vaginal wall fuses with the anoperineal body and the cervix, respectively. That portion of the vaginal wall which fuses with the cervix is almost completely devoid of muscle. The musculature of this third layer of the vagina is involuntary in type and relatively scant, consisting of a maximum of 15 per cent of the total structure of the entire vaginal wall. There is no definite arrangement into a circular and a longitudinal layer. The muscle fibers are almost always irregularly disposed into circular, oblique and longitudinal strands without any definite pattern.

Only in the four months' fetus was there a suggestion of a definite pattern. In this specimen a circular layer of muscle was found at all levels of the vaginal wall and at the cervicovaginal junction there was a longitudinal layer lying internally.

At all ages the muscle fibers become lost inferiorly in the tissues surrounding the introitus and superiorly in the outer portion of the fibrous stroma of the cervicovaginal junction. In the young adult the muscle is firmer in the middle third of the vagina, posteriorly and laterally. The muscle fibers are lost anteriorly in the compact urethrovaginal wall. With advancing age atrophy sets in and in the senile period there is almost a complete absence of muscle fibers. In the specimen from the three months' pregnant woman there was a suggestion of muscular hypertrophy.

The elastic element of the third layers, its most important component, is intimately interwoven with other elements. It is definitely related to the cardinal ligament. As the vessels descend into the vagina, they carry with them a rich supply of elastic fibers which become attenuated as they approach the lower portion of the vagina. In the upper portion of the vagina

they condense into a compact band-like structure, first evident in the six months' fetus, although they remain an integral part of the vaginal wall. There is no suggestion of a separate layer of elastica distinct from the other component parts of the third layer. In specimens from the older women in which there was atrophy of the muscular component, the outer elastica element appeared relatively more prominent.

CONCLUSIONS

The vagina is made up of three layers: (1) an inner mucous layer consisting of a stratified squamous epithelium, (2) substantia propria which contains fibrous tissue, fine and coarse elastic fibers surrounding nutrient vessels and is devoid of muscle fibers and (3) a layer composed predominantly of elastic tissue, a moderate amount of fibrous tissue and a few scattered muscle bundles.

There is no definite layer of muscle in the vagina; the few muscle fibers present are circular, oblique and longitudinal, the greatest amount, found in the middle third of the vagina, for the most part constitutes only 15 per cent of the entire vaginal wall.

The elastic tissue element is the most important component of the vaginal wall. It is more compact and abundant at the base of the cardinal ligament, following the blood vessels as they approach the cervicovaginal area. As the elastica descends into the vagina, it diffuses and intermingles with the fibrous tissue and muscle fiber elements and also forms a peripheral vaginal wall band.

There are no erectile tissue elements, no lymphatic nodules and no glands in the vaginal wall.

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CESAREAN SECTIONS—1937 TO 1946*

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SINCE the introduction of cesarean section into the armamentarium of the obstetrician, there have been many improvements made in technic which have greatly increased the safety of the operation. More recently the use of

TABLE I

INCIDENCE OF CESAREAN SECTION

Period	No. of Deliveries	No. of Sections	Percent-age of Incidence
Through 1936.....	40,288	1,113	2.7
1937–1941........	14,092	517	3.6
1942–1946........	22,246	924	4.1

chemotherapy and antibiotics as well as improved preparation of the patient for operation have decreased the risk of the procedure to the patient even further. It seems wise to re-evaluate our statistics in the light of these changes.

We have reported in two previous papers our statistics in cesarean sections from the time of the opening of our hospital in 1906 through 1936. This present report deals with sections (abdominal hysterotomy, twenty-six weeks or over) done in the ten years from 1937 through 1946. Whenever it has seemed to be of value, we have divided these operations into two five-year groups; the later five-year group is representative of our experience with the free use of chemotherapy, antibiotics and blood plus the use of extraperitoneal cesarean section when indicated.

Incidence. In the ten years of our study there were 36,338 deliveries of which 1,441 were cesarean sections, an incidence of 3.96 per cent. (Table I.) Comparing this with our previously reported incidence, it is apparent that there is a slow but obviously

continued tendency toward an increase in the incidence of cesarean sections. This somehow is to be expected both as a result of the marked increase in safety of the operation as well as the broadening of the indications. Nevertheless, it is wise not to

TABLE II

INDICATIONS FOR SECTION

	No. of Cases	Per cent	Per cent 1932–1936	Per cent 1908–1931
Repeat section...	376	26.1	23.1	
Disproportion.............	294	20.4	35.7	
Toxemia..................	144	10.0	8.4	5.0
Inertia.......	133	0.2		
Placenta previa...........	118	8.2	6.3	2.6
Abnormal presentation.....	101	7.0		
Elderly primipara..........	88	6.1		
Previous stillbirth(s).......	78	5.4		
Previous gynecologic operation...........	73	5.1		
Cardiac................ ...	54	3.7 (7.0)* (1.9)†	6.3	2.5
Fibroid uterus.....	49	3.4		
Sterility.............. ...	37	2.6		
Fetal distress....	22	1.5		
Diabetes...	19	1.3		
Ablatio placenta...........	14	1.0		
Obstructing tumors........	12	0.9		
Ruptured uterus...........	2	0.1		
Miscellaneous.............	18	1.3		

* 1937–1941
† 1942–1946

allow this trend to get out of hand as the degree of safety is in no way comparable to the safety of the normal vaginal delivery. One should always bear in mind, too, the cumulative risk of cesarean section as it is not alone the risk of the first section but of the second and third and even the fourth.

Indications. As in our previous report the repeat cesarean represents about one-fourth of our entire group. (Table II.) At the present time it is still our practice to follow the dictum, "once a cesarean, always a cesarean." It probably will remain our practice until such time as there is convincing proof of a marked reduction in the incidence of ruptured uteri in subsequent

labors—not only the immediate but the remote labors. We are well aware of the difference of opinion on this subject. When we are able to predict with accuracy the behavior of the scar in the uterus, we will probably change our attitude.

TABLE III
MATERNAL MORTALITY

	No. of Cases	No. of Deaths	Per cent of Mortality
Through 1936....	1,113	33	2.95
1937–1946........	1,441	13	0.9
1937–1941........	517	8	1.54
1942–1946........	924	5	0.54

The further increase in the importance of placenta previa and toxemia as indications for cesarean sections is to be noted. With regard to the former, a previously published report demonstrated the superiority in maternal result of cesarean section over every other type of treatment except simple rupture of membranes. As for toxemia, it has been our practice to terminate the pregnancy when we are unable to control progression of symptoms of pre-eclampsia by the usual methods. In the primipara, when the cervix is long, uneffaced and does not allow of easy rupture of the membranes, it becomes necessary to empty the uterus abdominally.

It is interesting to note the relative turnabout in our practice with regard to cardiac disease in the mother. For a while there was an increasing trend of cardiac disease as an indication for section until in the years 1937 to 1941 it reached its peak of 7.0 per cent of the cases sectioned. In the last five years it has dropped to 1.9 per cent and will probably drop even further as a result of the recently demonstrated tendency of cardiacs to tolerate labor at term well.

Maternal Mortality. It is a consideration of the maternal mortality that is by far the most important desideratum when one considers cesarean section. (Table III.) In our series of 1,441 we had thirteen deaths

or a rate of 0.9 per cent. On the other hand, in the last five years we have had only five deaths or a mortality rate of 0.54 per cent. This we believe is representative of our present mortality rate in cesarean section. It is exceedingly low yet we believed that if improvement is to occur, a thorough study of these thirteen deaths must be made.

CASE HISTORIES

CASE I. A thirty-seven year old woman, No. AA41162, 1937, gravida II, para 0, had a classical section done under general anesthesia after seven hours of irregular pains, with membranes intact. This patient had a history of a fourteen-year sterility following an ectopic pregnancy. She died on the fifth postoperative day of bronchopneumonia and Staphylococcus aureus hemolyticus sepsis.

CASE II. A twenty-four year old woman, No. AA45870, 1938, gravida III, para 0, had a low flap section done under general anesthesia for disproportion after thirty-five hours of labor and ruptured membranes which had existed for eleven hours. Signs of bronchopneumonia developed on the first postoperative day. Sulfanilamide was given from the fourth day on; a blood transfusion was also given. She died of sepsis on the eighth postoperative day.

CASE III. This patient, No. AA47711, 1939, gravida II, para 0, had multiple fibroids, breech and an android pelvis. Low flap section and myomectomy was done under general anesthesia after a few hours of irregular pains; membranes had been ruptured six hours. Her temperature varied from 100 to 101°F. from the first to ninth day; it became normal after the ninth day. The patient expired suddenly on the sixteenth day after collapsing in the bathroom. Death was ascribed to a pulmonary embolus; no autopsy was performed.

CASE IV. A thirty-two year old woman, No. AA48184, 1939, gravida VI, para II, was seen who weighed over 200 pounds, was short and very obese. Her first delivery was by craniotomy; second delivery was by version after forceps failed. Labor lasted eight hours. A breech extraction failed after both feet were in the vagina. Porro section was done under general anesthesia several hours later. Blood was given postoperatively. The baby weighed

12 pounds and 13 ounces. The mother died of postoperative shock within twenty-four hours.

Case v. A thirty-one year old woman, No. AA48368, 1939, gravida i, para o, was admitted when thirty weeks pregnant, with symptoms of ruptured uterus. She gave a history of multiple myomectomies eighteen months before. Classical section (and transfusion) was done under general anesthesia. She died seventy-two hours postoperatively of bronchopneumonia due to aspiration. The baby, weighing 3 pounds and 1 ounce, died.

Case vi. A thirty-five year old woman, No. AA60383, 1941, gravida vi, para ii, had an repeat elective reparative classical section done under single-shot spinal anesthesia (150 mg. procaine). Her blood pressure was 140/96 on admission but fell to 65/0 as the uterus was incised. The patient died of spinal shock as the uterus was being closed.

Case vii. A twenty-seven year old woman, No. AA60553, 1941, gravida i, para o, had a low flap section for disproportion under local anesthesia after eight and a half hours of pains; membranes were intact. A transfusion of 500 cc. was given once in the puerperium. Sulfathiazole was begun on the seventh postoperative day. She died of sepsis on the thirteenth postoperative day.

Case viii. A thirty-three year old woman, No. 247944, 1941, gravida i, para o, had an elective classical section performed under general anesthesia for obstruction due to a cervical fibroid. She was explored on the eighth postoperative day for an obstructive ileus. Adhesions and a pus pocket were found. Sulfa was given intravenously and also was left in abscess cavity. A total of 3,500 cc. of blood were given. She died of sepsis on the eighteenth day.

Case ix. A thirty year old woman, No. 261506 (General Service Case), 1943, gravida ii, para i, was seen at term. After a relatively short labor, with membranes intact, she became fully dilated. The vertex was unengaged due to a large cyst impacted in the pelvis. An attempt to push the cyst out of the pelvis under anesthesia with the patient in Trendelenburg was unsuccessful. Low flap section under general anesthesia and a left salpingo-oophorectomy for a large adherent cyst were performed. While walking around on the twelfth day, she died suddenly of a large pulmonary embolus proved by autopsy.

Case x. A thirty-five year old woman, No. AA79400, 1944, gravida ii, para i, had rheumatic heart disease. She gave a history of a previous section and having been hospitalized for decompensation for twenty days prior to time of section. Classical section and sterilization under local anesthesia were done at thirty-six weeks because of mild labor pains. She died on the tenth postoperative day of an unrecognized staphylococcus sepsis.

Case xi. A twenty-three year old woman, No. AA88873, 1945, gravida i, para o, with a congenital cardiac condition was seen. Elective classical section and right salpingo-oophorectomy for a cyst was done under fractional spinal anesthesia. She died suddenly on the second day after a very short period of marked dyspnea and cyanosis and was signed out as an embolic death. No autopsy was done.

Case xii. An eighteen and one-half year old gravida i, para o, No. AA97283, 1946, had an elective classical section done under fractional spinal anesthesia (50 mg. procaine) for cardiac disease. She went into shock and died on the table immediately after the baby was extracted from the uterus. She was signed out as a spinal death.

Case xiii. A thirty-seven year old woman, No. 298685 (General Service Case), 1946, gravida ii, para i, was seen at term. She had had a radical mastectomy for carcinoma, with metastases to bones, spine and lungs. She had refused interruption of pregnancy at four and a half months. Elective low flap section was done under local anesthesia. The patient died on second postoperative day of pneumonia.

COMPARISON OF RESULTS

It seems appropriate to compare our results in elective and non-elective cases. (Table iv.) As a result of our ten-year study it would seem that elective section (before the onset of labor or rupture of membranes) is to be preferred to non-elective section. However, if we divide our sections into five-year groups we find almost identical mortality rates for elective and non-elective cases. (Table v, Fig. 1.)

By referring to Table vi it is noted that the marked reduction in mortality in the last five years is entirely due to the almost complete elimination of sepsis as a cause of death. As a matter of fact the only death

due to sepsis (Case x) in the last five years was due to the fact that a staphylococcus septicemia was unrecognized until it was too late to affect the outcome.

Recently there has been mention of the greater risk entailed in repeat sections. Our
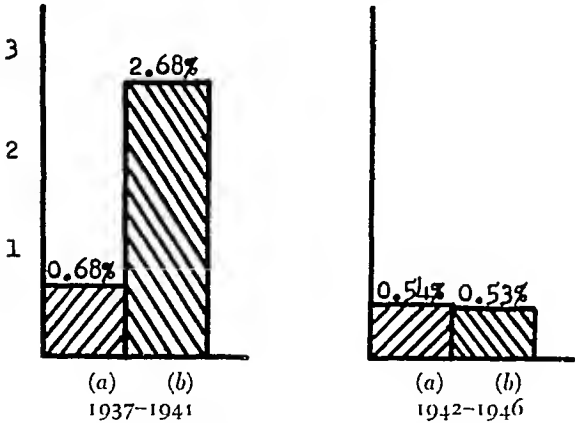

FIG. 1. Comparison of incidence of mortality in elective and non-elective cases; (a) elective; (b) non-elective.

own figures seem to indicate about half the maternal mortality for repeat sections as for primary sections. (Table VII.) The two deaths in repeat sections are represented

TABLE IV

COMPARISON OF MATERNAL MORTALITY IN ELECTIVE AND NON-ELECTIVE CASES

	No. of Cases	No. of Deaths	Per cent of Deaths
Elective.........	843	5	0.59
Non-elective......	598	8	1.3

TABLE V

COMPARISON OF INCIDENCE OF MORTALITY IN ELECTIVE AND NON-ELECTIVE CASES (IN FIVE-YEAR PERIODS)

	Elective Cases			Non-elective Cases		
Five-year Period	No. of Cases	No. Deaths	Per cent Deaths	No. of Cases	No. Deaths	Per cent of Deaths
1937–1941	292	2	0.68	224	6	2.68
1942–1946	551	3	0.54	374	2	0.53

by Case VI due to spinal anesthesia and Case x due to unrecognized sepsis.

A comparison of maternal mortality with relation to the type of section would seem to favor the low flap section and the extraperitoneal section as indicated by the mortalities even in the second five years. (Table VIII.) However, when it is considered that only one of the deaths was due to sepsis (and that one in an elective section),

TABLE VI

CAUSES OF DEATH

	Total	1937–1941	1942–1946
Sepsis.....................	5	4	1
Pulmonary embolus...........	3	1	2
Spinal anesthesia.............	2	1	1
General anesthesia............	1	1	0
Pneumonia (carcinoma).......	1	0	1
Shock (?)....................	1	1	0

a comparison is not justifiable. This is not to be interpreted as a point for complete disregard of the type of section as will be indicated in a discussion of morbidity.

Three of our deaths were due to anesthesia. One occurred as a result of aspiration pneumonia in a patient (with previous multiple myomectomies) who was given general anesthesia shortly after the patient ruptured her uterus during her seventh

TABLE VII

COMPARISON OF MATERNAL MORTALITY IN REPEAT SECTIONS AND PRIMARY SECTIONS

	No. of Cases	No. of Deaths	Per cent of Deaths
Repeat sections...	376	2	0.53
Primary sections..	1,065	11	1.03

month of pregnancy. This complication might have been avoided by gastric lavage prior to induction of anesthesia. The other two deaths occurred as a result of spinal anesthesia.

Figure 2 indicates the trend in our anesthesias. The great rise in spinal anesthesia resulted from the introduction of fractional spinal anesthesia. One of the deaths occurred from a single dose of spinal anesthesia before the use of fractional doses.

One death resulted from a 50 mg. fractional dose of procaine. No deaths resulted from local anesthesia in this group. We believe that a word of caution is indicated in the use of spinal anesthesia. While we believe that the fractional method of introduction considers that only forty of our patients had either a myomectomy or oophorectomy, this represents a high mortality. The tremendously increased vascularity of these tumors in gestation is well known and phlebothrombosis of the distended veins

TABLE VIII

COMPARISON OF MATERNAL MORTALITY IN RELATION TO TYPE OF SECTION

	Classical Section			Low Flap Section			Extraperitoneal			Porro		
	No. of Cases	No. of Deaths	Per cent of Deaths	No. of Cases	No. of Deaths	Per cent of Deaths	No. of Cases	No. of Deaths	Per cent of Deaths	No. of Cases	No. of Deaths	Per cent of Deaths
1937–1941	247	4	1.6	194	3	1.5	59	0	0	15	1	6.6
1942–1946	292	3	1.0	469	2	0.42	139	0	0	20	0	0

of the anesthetic agent in the subdural space is to be preferred to the single dose method, it is not without its dangers. At the present time we use the precaution of using very small doses (an initial dose of 25 mg.) and of having each patient receive

TABLE IX

PROCEDURES (OTHER THAN TUBAL LIGATION) DONE AT TIME OF SECTION AND RELATED MATERNAL MORTALITY

	No.	Deaths
Myomectomy...................	30	1*
Oophorectomy.................	10	2*
Section hysterectomy...........	35	1
Repair of ventral hernia.........	4	0

* All deaths due to pulmonary embolus.

intravenous fluids before, during and after the use of the spinal. The ready availability of a mechanical respirator will also prove of value in the exceptional case. Local anesthesia is still the anesthetic of choice in the vast majority of cases.

Three of our deaths were due to pulmonary embolus (clinical, only one autopsy report). (Table IX.) It was very enlightening to find that two of these patients had an oophorectomy for ovarian cyst at the time of operation and one had a myomectomy at the time of section. When one

upon removal is to be expected. It would seem to us that it would be important not to do myomectomy at the time of a cesarean unless it is necessary as part of the procedure. However, when it is imperative that this operation be done or when

TABLE X

MORBIDITY

	No. of Cases	No. Morbid	Per cent Morbid
Through 1936.....	1,113	505	46.5
1937–1946........	1,441	491	34.0
1937–1941........	517	259	50.0
1942–1946........	924	232	25.1

oophorectomy for cyst is performed, it is suggested that the patient be heparinized in the postoperative period to prevent embolization.

Thus, while it may seem that 0.54 per cent maternal mortality represents an almost irreducible surgical minimum, we believe that closer attention to our anesthetic problem together with anticoagulation therapy in cases in which myomectomy or oophorectomy is done at time of operation should further reduce this rate.

Sterilization usually is done at the second or third section in our hospital. In this series it was done in 347 cases.

As a concomitant of mortality one must always consider the morbidity of the patients surviving. (Table x.) For the ten-year period our morbidity was 34.0 per cent. The lack of significance of this figure is apparent when we break the figures up
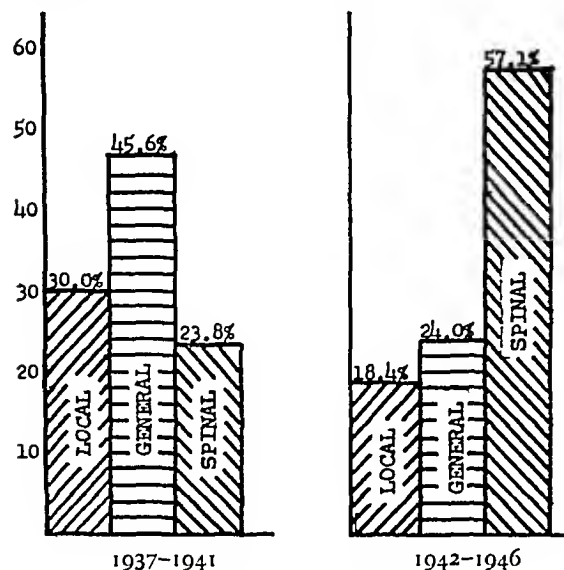

FIG. 2. Type of anesthesia.

into two five-year periods and it is seen that the morbidity for the period 1937 to 1941 was no different than the morbidity for the previous years, whereas the morbidity for the period 1942 to 1946 was practically halved. A further indication of

TABLE XI
INCIDENCE OF SEVERE MORBIDITY

	No. of Cases	No. Severe Morbid	Per cent Severe Morbid
1937–1941........	517	40	7.7
1942–1946........	924	17	1.8

this trend is seen by comparing the number of patients with severe morbidity (temperature elevation beyond six days after the first seventy-two hours). It is noted that the drop in the last five years is almost to 25 per cent of the former figure. (Table xi.)

In previous reports it was always apparent that there was a reduced morbidity associated with low flap section as com-

pared with classical section. This same trend seems to be present for the first five years of our series (Table xii) but entirely disappears for the second five years. However, this does not represent the complete picture as can be deduced from the fact

TABLE XII
COMPARISON OF MORBIDITY OF ELECTIVE CASES IN CLASSICAL AND LOW FLAP SECTIONS

	Classical Sections			Low Flap Sections		
	No. of Cases	No. Morbid	Per cent Morbid	No. of Cases	No. Morbid	Per cent Morbid
1937–1941	203	95	46.8	80	31	38.7
1942–1946	253	53	20.9	277	56	20.2

that many more of our patients who had low flap sections had longer periods of labor and more prolonged periods of existence of membranes. This is even more applicable to our group of extraperitoneal sections. (Figs. 3 and 4.)

TABLE XIII
FETAL MORTALITY

Total number of babies born...	1,452 (11 sets of twins)
Total fetal mortality..........	77 or 5.3%
Non-viable infants............	3
Monstrosities................	2
Viable fetal mortality........	72 or 4.9%
Prematures (less than 36 weeks)	67
Premature deaths............	26 or 38.8%
Corrected fetal mortality (corrected for non-viability and prematurity)...............	48 or 3.4%

We note no change in our results of fetal mortality over the years. (Table xiii.) Our uncorrected mortality (stillbirths and neonatal deaths) is 5.3 per cent. When corrected for prematurity and nonviability, our figure is 3.4 per cent, almost identical with our previously reported figure of 3.5 per cent. Even more significant is the fact that 39 per cent of the prematures were stillborn or died in the neonatal period. There may be a reduction obtained in the incidence of prematurity by the recently accepted expectant treatment for placenta previa.

SUMMARY AND CONCLUSIONS

1. There is a slow but definite increase in the incidence of sections. In our hospital

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the figure has risen from 2.7 per cent to 4.1 per cent in the last ten years. A similar increase has been observed in many of the large obstetrical clinics throughout the country. The reasons are to be found in the present day increased safety of the opera-

incidence of cardiacs managed by section is definitely on the decrease. We believe that most cardiacs can and should be allowed to deliver vaginally unless a definite obstetrical indication for section is present. These patients should be well sedated
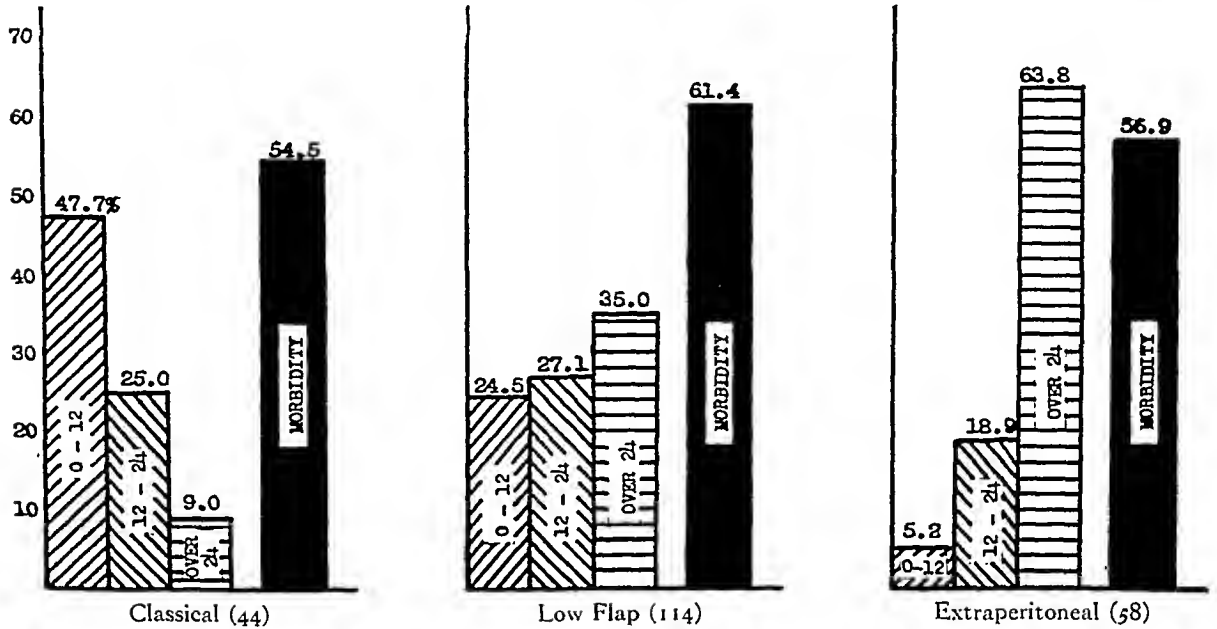
FIG. 3. Correlation between number of hours of labor, type of section and morbidity (1937–1941).
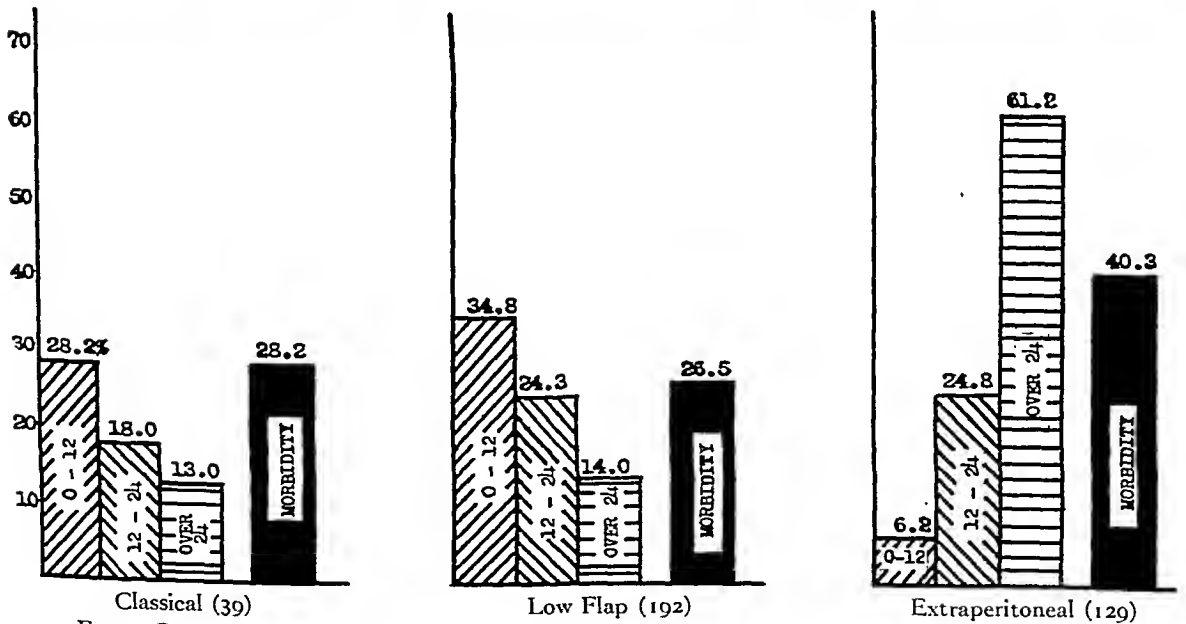
FIG. 4. Correlation between number of hours of labor, type of section and morbidity (1942–1946).

tion and in a broadening of the indications. More patients with placenta previa and progressive pre-eclampsia are sectioned today than five or ten years ago while the

during the active phase of labor and have the second stage shortened. It is not necessary or desirable to subject a cardiac to section merely for the sake of sterilizing

her. This, when desired, can be done in the early puerperium with much greater ease and safety.

2. Maternal mortality during the last five years is 0.54 per cent as compared to 1.54 per cent, the mortality figure for the first five years. The maternal morbidity likewise has fallen from 50.0 per cent to 25.1 per cent. Of particular interest is the sharp drop in severe morbidities from 7.7 per cent to 1.8 per cent. All of these considerable reductions in mortality and morbidity are due to a group of fairly constant factors. First, there is better preoperative preparation of the patient, including the liberal use of blood when indicated; second, there is the early (and frequently the prophylactic) use of antibiotics and sulfa drugs; and last, the extraperitoneal section in indicated cases. The almost complete disappearance of sepsis as a cause of death in our last 924 sections is a striking example of the efficacy of the aforementioned factors.

3. The mortality in elective sections for the entire ten-year period is about one-half (0.59 per cent) of the mortality for the non-elective cases (1.3 per cent). During the last five years, however, the mortality figure of 0.54 per cent for all sections (elective and non-elective) is practically the same as the mortality figure of 0.59 per cent for the elective sections of the entire ten-year period. The reasons are the same as those given for the general decline of mortality and morbidity.

4. The three anesthesia deaths reported must be considered as preventable mortalities. Two of the three were due to spinal anesthesia and one to general anesthesia. While there has been a sharp increase in the use of spinal anesthesia in recent years, especially since the introduction of fractional spinal, we should be cognizant of the fact that any form of spinal anesthesia entails a certain risk, even in the hands of the well trained medical anesthesiologist. It is our opinion that local anesthesia is still probably the safest anesthesia and, with a little time and patience, can be administered to most patients to be sectioned.

5. The three embolic deaths are quite instructive and, therefore, worthy of comment. Two were associated with salpingo-oophorectomy for ovarian cyst and one with myomectomy. Three embolic deaths in a group of forty patients in whom some additional procedure (other than tubal ligation) was done at the time of section is a high mortality and is probably associated with the marked vascularity that these tumors show in the presence of a term pregnancy. It is quite possible that postoperative anticoagulant therapy of such cases may, in the future, decrease the incidence of death due to embolus.

6. The fetal mortality of 5.3 per cent, even when corrected to 3.4 per cent, is still as high as the previously reported one of 3.5 per cent. This is rather discouraging, particularly in view of the sharp reduction of maternal mortality and morbidity. Possibly a policy of temporizing in selected cases of placenta previa until a viable fetus is obtainable may help to reduce the fetal mortality to some extent.

PNEUMATOSIS INTESTINALIS*

ROENTGEN DIAGNOSIS AND SURGICAL MANAGEMENT

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PNEUMATOSIS intestinalis is so little known that when it occurs it presents a challenge to diagnosis and management. The variations in degree and type, the discrepancy between the sparse clinical and the extensive operative findings, the diversity of pathologic conditions all invoke the exercise of keen judgment based on an appreciation of the fundamental nature of the disease.

Since pneumatosis is defined as the presence of gas in an abnormal location in the body, the diffuse spread of gas into the intestinal tissues is labeled pneumatosis intestinalis. The arrangement of this gas in cyst-like accumulations within the wall of the intestine and its mesenteric attachments may be designated as pneumatosis cystoides intestinalis. This entity has been reported in the literature as "gas cysts of the intestine," "emphysema intestinorum," "cystic pneumatosis of the bowel" and "pneumatosis cystoides intestinorum hominis."

It is generally agreed that Bang in 1876 published the initial description of a human case of pneumatosis intestinalis. Prior to that data an analogous condition occurring in animals, notably swine, had been recognized.[14] The first report in the American literature was by Finney[6] in 1908. The most recent review was published in 1940 by Jackson[8] who collected all the previous cases and, adding his own, brought the total to 172. Of these, eleven were children and one hundred sixty-one were adults. Since that date, there have been numerous (at least seventeen) reports in the foreign literature but only two contributions from the United States.[9,10]

Roentgenologic diagnosis was lacking in American reports until the case presented by Lerner and Gazin[9] in 1946 which, however, had no operative confirmation. The first preoperative roentgenologic diagnosis that we have been able to find was reported by Baumann-Schenker[1] in 1939. This author states that Von Mengis (1934) cited two previous preoperative roentgenologic diagnoses. He also declares that a few other preoperative diagnoses are extant but gives no references. The case we are presenting is the first instance in American literature to be diagnosed preoperatively and confirmed both by surgery and histologic study.

ETIOLOGY

Three major hypotheses have been advanced to explain the production of this entity:

1. *Neoplastic.* Bang and Finney[6] believed that the process was a distinct type of tumor, the cells of which were capable of forming gas. This concept has never received histopathologic substantiation. The spontaneous disappearance of intestinal emphysema in many proved cases also serves to refute this theory.

2. *Infection.* The majority of bacteriologic studies in man have failed to demonstrate bacteria[13,19] and the analysis of gas from the cyst-like areas has disclosed the presence of oxygen,[14] a finding not likely

to be associated with a bacterial origin of the gas. The microscopic picture is not entirely consistent with an infectious process. No report has been found in the literature with respect to the part that fungi or parasites may play in this entity.

3. *Mechanical.* Most authors[4,8,14,19] postulate a break in the continuity of the mucosa with escape of intestinal gas into and through the intestinal wall. Analysis of the cases previously reported in the literature reveals that the majority are associated with some form of intestinal obstruction, predominately pyloric stenosis. An attempt to reproduce this entity in experimental animals by injecting air submucosally has resulted in escape of the gas into the perivascular, serosal and mesenteric lymphatics, forming cysts in the mesentery and retroperitoneal tissues but not in the local bowel wall.[4] Pertinent evidence includes an autopsy described by Botsford and Krakower[4] in which a wedge—shaped distribution of emphysema was traced to reveal its apex at the mucosa.

The absence of pneumatosis intestinalis in the vast majority of cases of acute or chronic bowel obstruction or in cases of enteritis with partial bowel obstruction has caused hesitancy in acceptance of a purely mechanical basis for intestinal emphysema. However, increased intraluminal pressure and some degree of obstruction have been too frequent to be disregarded and appear to provide the logical explanation for the initial passage of gas through the mucosa.

We suggest that the spread of the gas into the lymphatic system results in obstruction to lymphatic drainage. The development of inflammatory changes then prevents adequate absorption of the gas from the bowel wall. In those instances in which the factors of lymphatic obstruction and inflammatory change are minimal or reversible the condition resolves itself following surgical rectification of the bowel obstruction. Should the obstruction persist and the inflammatory changes become chronic, the process becomes progressively worse.

PATHOLOGY

The gross appearance has been described as resembling "massive colloid carcinoma,"[15] "beginning echinococcus cyst"[6] and "hydatid mole cysts."[12] As the gas penetrates the bowel wall and comes to lie in the subserosal plane it may dissect between the layers of the mesentery and may pass into the retroperitoneal space. In this manner it is possible for the gas to reach the subdiaphragmatic region and conceivably enter the mediastinum. The distribution of the cysts may be patchy with skip areas or be well localized. There is a tendency for the gas to accumulate into cyst-like formations which are "massed together like soap bubbles in a basin of suds."[6] The cysts may vary from microscopic size to 3 cm. or more in diameter. The loculations may have their shape changed when the gas is forced along tissue planes by extrinsic pressure. The dissection of the gas into the submucosal region may cause the mucosa to encroach on the lumen of the bowel to such a extent as to produce obstruction.[14] It should be emphasized that the gas is exclusively "extraperitoneal" unless a break in the peritoneum ensues.

In the majority of cases the pneumatosis has been localized to the terminal ileum. In some instances it has involved the stomach, duodenum[1] and colon.[21] Analysis of the gas contained within the cyst has revealed that it is odorless and noninflammable.[6] A few chemical analyses have been made which suggest that the content of the cysts is a gas closely resembling atmospheric air.[13,14]

Microscopically, the tissue consists of numerous cysts without obvious content and devoid of a demonstrable epithelial or endothelial lining.[4,8] Several investigators[14] have thought that the cysts are actually lined with endothelium rather than being simple clefts in connective tissues. Varying degrees of inflammatory changes are found in the vicinity of the blebs. Hemorrhage, edema, granulocyte infiltration and giant cells have been reported but they are not

constant features. Pertinent experimental studies by Wright[26] on the local reaction to the injection of gases into tissue have shown that giant cells appear at the end of about a week and that the air-containing spaces become lined with flat mesothelial-like cells after about six to eight days. These latter cells are thought to originate from the connective tissues. The giant cells and endothelial lining reported by others as so characteristic of the air cysts would appear from Wright's work to be a manifestation indicating chronicity.

From the material presented by Botsford and Krakower[4] it seems that there is a tendency for gas to accumulate in the submucosa in children as contrasted to its predominately subserosal location in adults.

CLINICAL DIAGNOSIS

There are no pathognomonic clinical findings. Usually the underlying disease, some form of intestinal obstruction, produces the predominant symptomatology. The pneumatosis is most often a surprising finding at operation or at postmortem. The preoperative diagnoses have varied, pyloric stenosis being the most common. In an analysis of eighty-five reported cases[14] with twenty-nine postmortem examinations the cause of death in 31 per cent was some complication of a gastric or duodenal ulcer. Of fifty-two operated patients 65 per cent had a gastric or duodenal ulcer. Approximately 50 per cent of the eighty-five cases were therefore associated with ulceration of the stomach or duodenum. Of this group 83 per cent were accompanied by some degree of stenosis.

It is conceivable that crepitation of the intestine might be elicited on abdominal palpation of such a patient, but no instance of this observation has been recorded. Diarrhea is often present and has been noted as a prominent symptom in children.

The diagnosis then rests on the roentgenologic demonstration of the cysts in association with the manifestations due to intestinal obstruction.

ROENTGENOLOGIC DIAGNOSIS

The appearance of the radiograph in pneumatosis intestinalis is characteristic. Once seen it should never be missed. It consists of localized accumulations of gas manifested as relatively circular translucent shadows outside the lumen of the bowel. The gas may also appear as radiolucent streaks, irregular patches or multilocular formations. The usual location of the gas is subserosal following the contour of the bowel wall or outlining the mesenteric or retroperitoneal planes. Occasionally enough gas may accumulate in the bowel wall to cause invagination of the mucosa,[9] resulting in narrowing of the lumen. When the gas dissects along the retroperitoneal planes, it may come to lie between the parietal peritoneum and muscular layer of the diaphragm simulating a pneumoperitoneum. In this situation, however, it cannot be displaced from its subdiaphragmatic location as may be done when it is free in the peritoneal cavity. Should the cysts rupture forming a pneumoperitoneum, gas may then be seen within, in and outside the bowel wall.

The conditions which must be considered in the roentgenologic differential diagnosis are those caused by gas-producing organisms or those due to traumatic or operative introduction of gas into the tissues. We have seen pneumatosis following retroperitoneal rupture of the duodenum, faulty placement of gas in perirenal insufflation and in artificial pneumoperitoneum.

TREATMENT

Turnure[20] suggested that the treatment of pneumatosis intestinalis was the correction of the fundamental or predisposing disease. He believed that the condition was self-limiting with a tendency toward spontaneous cure and if the factors contributing to the obstruction were treated there was no indication for resection of the affected bowel or any attempt at removal of the cysts.

That the pneumatosis will resolve has been borne out by case reports in the past.

Fig. 1. Supine position April 30, 1947; dilated small bowel; upper abdomen overlaid by reticular pattern.

The case reported by Lerner and Gazin[9] showed a resolution of the pneumatosis intestinalis without operative interference. Mori in 1907 demonstrated that the gas cysts may undergo spontaneous resolution when nine months following an exploratory laparotomy he again entered the abdomen and found complete absorption of a former pneumatosis intestinalis. Berglund's patient[3] showed complete resolution of the pneumatosis at relaparotomy after three weeks. ·

When the process becomes irreversible, surgery may become necessary. The initial approach should be aimed at eliminating the obstructive factor. Simple lysis of adhesions has in some instances been sufficient to allow complete resolution of the pneumatosis. In others, secondary operations with bowel resection or short-circuiting procedures may be required. Surgical puncture of the cysts has been performed but they tend to reform.

CASE . REPORT

The patient was a twenty-three year old, married, white female who was admitted on April 29, 1947, with complaints of almost constant abdominal distention, diarrhea and bouts of crampy abdominal pain.

In November, 1946 the patient consulted her local doctor in another city because of a rather profuse vaginal discharge. She was told she had a "precancerous lesion" of the cervix. On the 19th of November a cervical amputation, a partial suspension of the uterus, a bilateral tubal resection and an appendectomy were done. The postoperative course was stormy. Following the operation, the patient developed peritonitis with signs and symptoms of intestinal obstruction. One week after the first operation there was an evisceration through the lower midline wound. A week later she was again operated upon by her local doctor to relieve the intestinal obstruction. During the second operation "one portion of the small gut was perforated." Since this operation, the patient has complained almost constantly of abdominal distention and diarrhea. There have been two episodes of relatively acute crampy abdominal pain, the last occurring three weeks before admission to the Salt Lake County General Hospital. The family and present histories were non-contributory.

Physical examination revealed the following: blood pressure 112/72; temperature, 98.2° F.; pulse 84; respirations, 18. The patient was a very thin, young woman who appeared several years older than her stated age. She was in no acute distress. Essential findings were confined to the abdomen which was thin and protuberant. There was an incisional hernia in a lower midline scar extending from the umbilicus to the symphysis pubis. On observation one noted hyperperistalsis. The bowel was easily palpated but no crepitation was noted. There was rushes of borborgymi and high-pitched sounds. A moderate amount of fluid was demonstrable in either flank. There was no abdominal tenderness nor were any masses palpable.

Pelvic examination revealed a parous outlet. The vagina was clean. The cervix had been amputated flush with the vaginal wall. The site was well healed and a patent os could not be demonstrated. The corpus was fixed anteriorly, was somewhat tender but was not enlarged. No adnexal masses were felt.

Urinalysis, red blood count, bleeding time, coagulation time, blood urea nitrogen, plasma proteins, blood chlorides, Kahn, Mantoux and urine cultures were all normal.

FIG. 2. Erect position same day as Figure 1. (1), Gas under each leaf of diaphragm; (2), loops of small bowel separated by gas; (3), inverted "U" effect due to subserosal gas.

FIG. 3. Magnified view of left lower quadrant of Figure 2. (1), Gas between loops of small bowel; the inverted "U" is produced by gas in lumen of small bowel (2), wall of small bowel (3) and subserosal air (4). The reticular pattern is best reproduced on the figure. The cyst-like loculations of relative radiolucency are especially prominent to the left of the figure's center.

Scout films of the abdomen on April 30, 1947, revealed the following: In the supine position the upper half of the abdomen, especially the right upper quadrant, was overlain by irregular areas of relative radiolucency, forming a reticular pattern. (Fig. 1.) These areas varied in size and shape from pin point to approximately 1½ cm. in diameter, lying in close apposition to each other and appeared to be separated only by an irregular network of relatively denser strands. There were several loops of gas-filled distended small bowel. One segment was especially prominent and crossed the abdomen diagonally to taper to a point at the level of the inferior margin of the left sacro-iliac joint. There was a moderate amount of gas in the large bowel.

In the erect position there had been a marked shift in the position of the reticular pattern which now occupied the lower abdomen, especially the left lower quadrant. (Fig. 2.) The pelvis was overlain by a diffuse haze. There was a small amount of gas beneath each leaf of the diaphragm. Several loops of distended small

bowel occupied the left lower quadrant. Two of these loops were separated by a narrow radiolucent area which allows delineation of the individual intestinal walls. There was also a loop of bowel, seen on end, which resembled an inverted "U" due to the differentiation between the gas in its lumen, the denser bowel wall and a strip of radiolucent gas following its outer contour. (Fig. 3.)

The gas beneath the right leaf of the diaphragm had shifted to overlie the liver in its lateral portion. The uppermost portion of the abdomen on this lateral film was occupied by distended loops of bowel which showed the peculiar net-like pattern. The dependent portion of the abdomen was obscured by a diffuse haze.

The contrast medium given on May 1, 1947, delineated a normal large bowel. The pneumatosis shifted considerably as contrasted to the relatively fixed large bowel and appeared to lie in the anterior portion of the abdomen.

The diagnosis was (1) intestinal obstruction, small bowel, partial; (2) hydropneumoperi-

FIG. 4. A loop of small intestine showing extensive involvement with subserosal gaseous cysts. Next to it is a segment of dilated but uninvolved small bowel.

FIG. 5. This shows the foamy, nodular character presented on the surface of the small intestine. The translucent cysts are of different sizes; gas cannot be milked from one cyst to another.

toneum; (3) pneumatosis intestinalis, involving small bowel and its attached mesentery.

A significant feature about this patient was the fact that despite the uncommon roentgen findings she at no time seemed acutely ill. Indeed, at one time her condition was so good that she obtained permission from the staff to spend an afternoon visiting and shopping in the city.

On May 8, 1947, the old operative scar was excised and a midline hypogastric incision was made. Upon entering the peritoneal cavity no free gas was encountered; (in the week since the roentgenograms were taken it seemed that the free gas had been absorbed.) There was a moderate amount of slightly brownish, somewhat turbid, thin, odorless fluid present. The intestines presented a remarkable appearance. Most of the small bowel was involved by adhesions some of which were long and stringy. After lysis of numerous adhesions it was found that the first 45 inches of the jejunum distal to the ligament of Treitz appeared normal. The next 15 inches showed distention but no other gross abnormality.

The following 48 inches were involved by pneumatosis. Here the intestinal lumen was distended and the walls thickened. The serosal surface was raised in a foamy nodular fashion by a great mass of translucent, thin-walled cysts of various sizes. (Figs. 4 and 5.) Most of these cysts contained gas which was odorless. A few of them contained a small amount of fluid. In some places the blebs extended down into the mesentery which presented a "shredded" appearance due to numerous ragged rents. This sector of bowel showed

marked distention down to a point where the intestine was sharply kinked and firmly adherent to the pelvic organs. The remaining distal portion of the small bowel was normal in appearance. The large intestine was not involved nor could any similar cysts be found in the walls of the other viscera or in the parietal peritoneum.

The obstructive attachment of the bowel to the pelvic organs was freed and the small intestine carefully examined for intraluminal obstruction. It was then possible to milk air in the small intestine from the ligament of Treitz to the ileocecal valve. The gas in the individual cysts could not be forced into adjacent cysts.

Because the external cervical os had been destroyed, a supravaginal hysterectomy was done with removal of the right ovary. The floor of the pelvis was reperitonealized and the abdomen closed with repair of the incisional hernia. The patient was in a good condition after the operation.

Postoperatively, the patient did well. Wangensteen suction was used for thirty-six hours. She had no distress after removal of the suction tube. Tension sutures were removed on the eighth day following operation. The wound at that time was well healed. Postoperative x-rays revealed the disappearance of a large percentage of the pneumatosis intestinalis. A small amount was still present in the lower left quadrant on the ninth postoperative day, with moderate distention of the small bowel.

The patient was discharged on the eleventh postoperative day. She was seen in the fifth

postoperative week and had gained 7 pounds in weight. She still had occasional short-lived episodes of abdominal pain and distention but no diarrhea. Consequently, five weeks following the first operation she was hospitalized for a forty-eight-hour observation period and conservative therapy. Despite utilization of 100 per cent oxygen inhalations, belladonna and a Cantor tube to relieve the distention, she continued to have recurrent bouts of meteorism and remained quite uncomfortable.

Ten days later a roentgenogram revealed a recurrence of the pneumatosis. The results of the period of conservative therapy were then judged to be inadequate and laparotomy was decided upon as the next procedure.

At the second operation on July 18, 1947, the intestines presented a gross appearance similar to that seen at the first operation, but this time the pneumatosis was more extensive, involving the whole mid-portion of the small intestine for a distance of 12 feet. The mesentery was slightly involved. The stomach, colon and retroperitoneal tissues were free of changes. There was approximately 200 cc. of blood-tinged fluid in the abdominal cavity. An interesting observation was that the pneumatosis involved the segments of bowel in such a fashion as to suggest that direct extension had occurred across adhesions between serosal surfaces of adjacent loops of bowel. An otherwise normal loop of bowel would seem to be involved where it became stuck to a tangle of emphysematous intestine. The gas in the blebs again had no odor. A large cyst filled with approximately 100 cc. of fluid was adherent to the anterior abdominal wall. The adhesions were more numerous than at the time of the first operation and were generally broader and firmer. Cultures were taken of a large and a small cyst as well as of the free abdominal fluid.

Fourteen feet of small intestine (extended length) were resected. This included all of the grossly involved small bowel and left the patient with 4 feet of normal-appearing jejunum and 9 inches of terminal ileum. An open, end-to-end anastomosis was performed without difficulty.

Postoperatively the patient did well. There was no distention and roentgenograms showed no evidence of pneumatosis one week following surgery. Five months after discharge the patient was free of distention and pain and had gained 20 pounds. Fatty foods in moderate
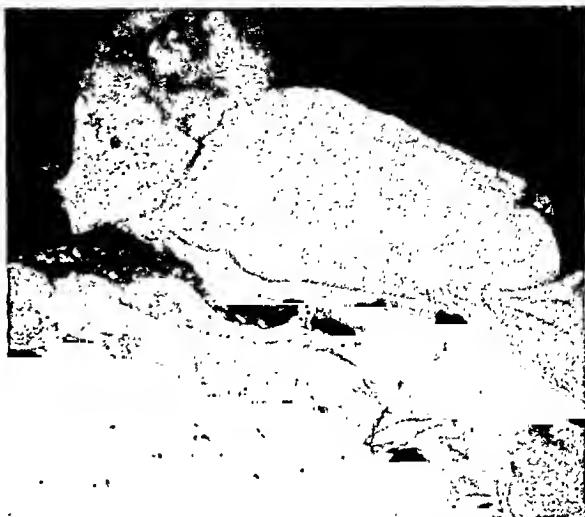
Fig. 6. Opened segments of resected bowel. The distal end is smaller than the proximal end which is almost twice its diameter. The segments are grossly involved with pneumatosis intestinalis externally but the mucosal surface is entirely devoid of cysts.

quantity were well tolerated and she had only one bowel movement a day. An erect scout film of the abdomen and a study by barium enema failed to reveal evidence of intestinal emphysema at this time.

No growth in the cyst and abdominal fluid was reported under aerobic or anaerobic conditions, using blood agar, Sabourauds, thioglycollate and broth media. Direct smears were negative for bacteria, molds, fungi or parasites. Intraperitoneal inoculation of the patient's cystic and intra-abdominal fluid into white mice did not kill the animals in four weeks.

Grossly, almost the entire specimen of resected bowel was involved by the process. (Fig. 6.) This consisted of numerous small, gas-containing blebs or cysts over the entire serosal surface, varying in size from pin point to that of a large olive pit. (Figs. 4 and 5.) The accumulations of gas appeared to be larger toward the distal than the proximal end of the bowel. These cysts were elevated, separating the serosal covering from the subserosal layers. The lumen of the bowel was larger than normal. This was particularly true of its proximal portion. There were many ragged, fibrous adhesions present along the serosal surface. Both internal and external inspection of the entire intestine failed to reveal any demonstrable break in the mucous membrane. (Fig. 6.) The small cysts resembled to a great degree those found in a hydatid mole except that here only a few contained cloudy fluid. The gas within
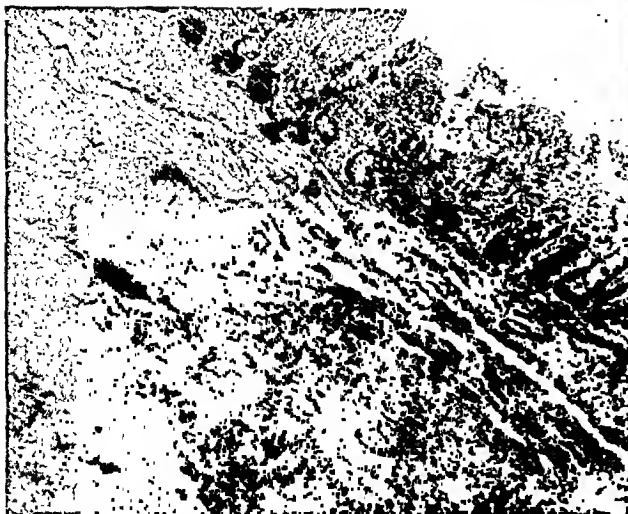
FIG. 7. The mucosa is infiltrated with plasma cells, lymphocytes and eosinophils. No gas is seen in the submucosa. This contrasts sharply with Figure 8 in which gas cysts are seen in the subserosal area.
FIG. 8. A low power view of the full thickness of intestinal wall. The discrete gas cysts lie entirely external to the muscular coats of the bowel wall.
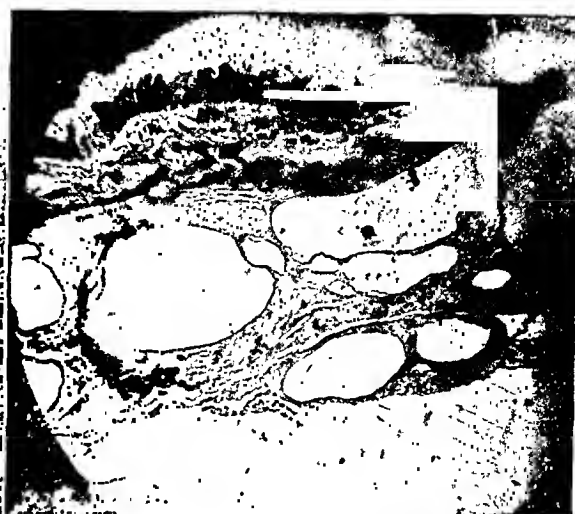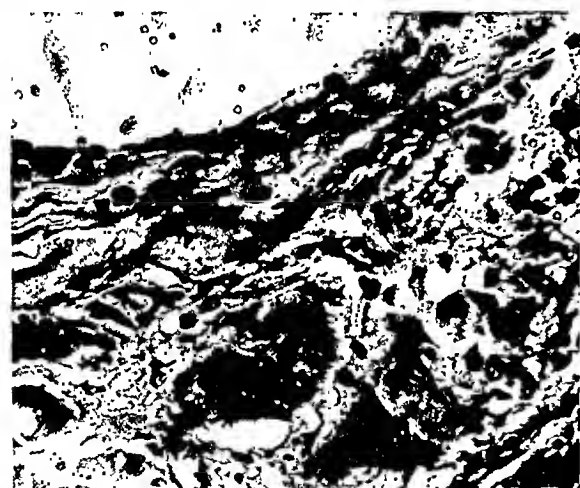

FIG. 9. Giant cells surrounded by eosinophils and lymphocytes; the clear space is a subserosal gas cyst.

the cysts could not be milked out or forced along the subperitoneal planes. Upon rupturing the cysts the gas acted as if it were under pressure.

Microscopically, the mucosa was infiltrated with plasma cells, lymphocytes and eosinophils. (Fig. 7.) The muscularis itself was not involved in the cystic process. In some areas it showed a moderate amount of fibrosis and infiltration with few lymphocytes. Opposite the large subserosal cysts the muscular layers were thinned, probably due to pressure from the accumulations of gas. Within the subserosal layer of the wall there were many clear cystic areas varying in size from 1 to 10 mm. in diameter. (Fig. 8.)

Upon examination it appeared that some of these cysts were lined by "endothelium." In many instances the cyst wall was devoid of any cell lining. At some points in the walls there were numerous macrophages and eosinophils. In a few places focal hemorrhages were seen. An interesting finding was a layer of collagenous and granulomatous tissue containing many lymphocytes, plasma cells and eosinophils surrounding some of the cysts. Giant cells containing two to twenty nuclei and giant cell granulomas were also seen in scattered areas. (Fig. 9.) The distribution of the cysts did not follow a definite pattern. They appeared to be discrete and variable in shape and size.

COMMENTS

Although pneumatosis intestinalis has been reported more frequently in recent literature it is still of sufficient rarity to warrant another case report. The terminology used in European literature has been carried over into the American. It may be that subsequent reports in the literature will prefer the term intestinal emphysema to pneumatosis intestinalis.

The incidence of diagnosis is undoubtedly based upon the awareness of the physician to the presence of such an entity. Once seen it is not likely to be forgotten. It should be remembered in the differen-

tial diagnosis of any case of intestinal obstruction.

The numerous theories as to the entry of gas into the bowel wall can probably be disregarded with the exception of the mechanical factor superimposed on an ulcerative lesion. Once the gas has attained access to the subserosal muscular place it appears to produce mechanical obstruction of the lymphatics and inflammatory changes, resulting in progressive intestinal emphysema. The cysts apparently represent accumulations of gas which cannot be disseminated or absorbed.

The clinical diagnosis may be suspected by an individual familiar with the entity. The actual diagnosis rests upon radiologic demonstration and surgical proof. The characteristic x-ray finding of radiolucent streaks or discrete loculations scattered along the bowel wall should therefore be made familiar to everyone. The possibility that these accumulations may rupture and permit escape of the gas into the peritoneal cavity forming a pneumoperitoneum should also be remembered.

The treatment depends upon the individual case. Since many of the cases resolve without surgery, it is probably wisest at first to follow a conservative medical or surgical program. If the condition becomes progressive or is recurrent, then radical resection or a short-circuiting procedure may be necessary.

The case reported herein is classical in that the patient had the typical clinical picture of intestinal obstruction, diarrhea and extensive pneumatosis intestinalis upon x-ray. In place of the common finding of associated pyloric stenosis this patient's stenotic factor was multiple intestinal adhesions.

SUMMARY

The first American report of a roentgenologic preoperative diagnosis of pneumatosis intestinalis is presented. The characteristic roentgenographic features are described.

The various etiologies of this entity are

discussed and a theoretical concept of its development is presented. It is suggested that the process is as follows: A break develops in the mucous membrane of the bowel associated with some form of partial or complete obstruction of a part of the intestinal tract distal to this mucosal defect. The obstruction may occur from stenosis or adhesions. Because of the obstruction, hyperperistalsis take place and forces gas out of the lumen of the bowel into the wall where it comes to lie either in the subserosal or the mucosal layers. The presence of the gas causes obstruction of the lymphatics and associated inflammatory changes. Normally the gas is re-absorbed. If, however, the inflammatory and stenotic factions persist in the lymphatic system and become marked, absorption of the gas is blocked and the process become irreversible.

The problem of conservative versus radical surgery in the treatment is raised. It is the opinion of the authors that the management of this entity demands a careful evaluation of the stage to which any given case has progressed. If the features of the case appear to be irreversible, radical surgery is indicated. In many cases simple relief of the obstruction may be sufficient. The case presented in this report is one in which conservative surgical management (lysis of adhesions) was tried at first, only to require the more radical procedure of extensive small bowel resection at a later date.

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MALIGNANT TUMORS OF THE SMALL INTESTINE*

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MALIGNANT tumors of the small intestine demand not only early roentgenographic study for their recognition but also closer clinical observation of the characteristics and development of the morbid process. The onset of the disease is so insidious that marked asthenia and severe anemia may be present before the disease encroaches on the lumen as the correct diagnosis is rarely made before the onset of partial obstruction. Fractional radiographic examination before obstructive symptoms are manifest have not infrequently failed to disclose proximal distention or interference with mobility. The rapid extension of the disease into the rich, inaccessible lymphatics often preclude a successful outcome even though technically the disease and adjacent mesentery appear to have been extirpated. Four cases are reported because they manifest different phases of the morbid process.

CASE REPORTS

CASE I. No. 55812, B. G., a forty-five year old male, was admitted to Beth Moses Hospital on October 25, 1932, complaining of pain and vomiting. In 1920 a cholecystectomy and appendectomy had been performed. For about two months before admission he was treated in the out-patient department of another hospital for pain in the epigastrium. There he had a gastrointestinal series. He was told that he had an ulcer and was placed on a Sippy diet. The pain came on before and after meals but was not severe enough to keep him from working. He noticed that he was getting weaker. For two days before admission the pain was in both lower quadrants. The pain was sharp, stabbing in character, did not radiate but was intermittent and aggravated by deep breathing. This persisted until admission when the pain became localized in the epigastrium and the

stools became black. The patient had lost 18 pounds in five months.

At examination, the patient looked drawn, chronically ill and emaciated. He weighed 157 pounds. The abdomen was distended and there was resistence and tenderness in the right upper quadrant. There also was tenderness in peri-umbilical regions. Some irregularity was noted in the epigastrium. There was marked right costovertebral tenderness. Laboratory data were: red blood cells 4,350,000, 65 per cent hemoglobin, white cell count 12,920, polymorphonuclears 87 per cent; Wassermann negative, stools positive for blood; sugar 125 mg. per cent, urea nitrogen 15 mg. per cent, chlorides 385 mg. per cent, icteric index 6.9, cholesterol 225, ester 72, per cent 32. Fractional gastric analysis revealed free acid ranging from 14 to 29, total acidity from 42 to 59, bile was 4+ and only the initial specimen showed a trace of blood; urine was negative.

For the next ten days the temperature fluctuated from 99 to 101°F. There was persistent tenderness in the right upper quadrant and epigastrium. The white cell count on alternate days varied from 5,400 to 14,000. Repeated radiographic examinations of the diaphragm suggested right diaphragmatic adhesions. The chest did not show any adventitious shadows. No barium studies were made because a diagnosis of a sealing-off perforating ulcer was entertained. Intermittent gastric suction and supportive parenteral feedings were instituted. Spasm and tenderness persisted over a mass which was palpable in the upper right half of the abdomen. The general condition of the patient did not seem to improve. Operation was advised for a presumptive diagnosis of a walling off perforating carcinomatous ulcer of the stomach.

On November 4, 1932, under spinal anesthetic and a blood transfusion the abdomen was opened through an upper right, rectus incision. A cystic, firm pearly gray-yellow mass 15 cm. in diameter was found ulcerating

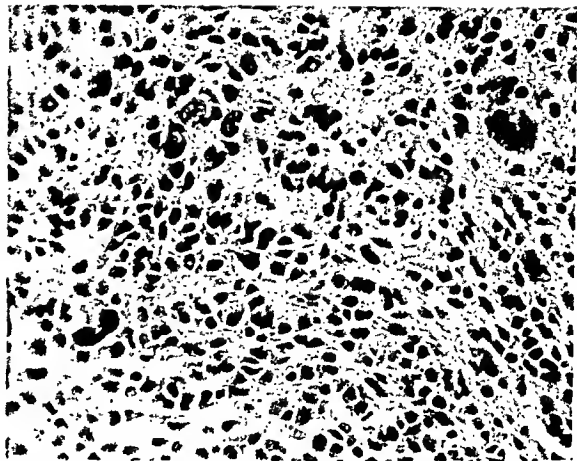FIG. 1. Case 1. Myosarcoma of duodenum with portion of stomach.

FIG. 2. Case 1. Cellular atypism with structural changes of myosarcoma.

fluids but he died on the fourteenth day. Autopsy revealed a leakage of the gastro-duodenal anastomosis and bronchopneumonia.

Comment. This patient presented an extrinsic degenerated and bulky sarcoma of the duodenum causing compression of the lumen and illustrated the difficulty of early radiographically establishing the presence of an extrinsic tumor. While technically the resection and a Billroth No. 1 was readily effected without tension, it is apparent that the procedure of choice should have been a short circuiting operation to decompress partially the edematous tissue followed by resection at a subsequent date.

into the first and second portions of the duodenum and attached to the posterior wall of the stomach. The mass contained about 1 pint of dark brown clear fluid. The tumor could be readily separated from the stomach, from the undersurface of the liver and from the thin posterior adhesions. Nodular masses were noted in the retroperitoneal tissue and in the leaves of the omentum. There was no extension into the pancreas. The right kidney was small and grossly normal. The first and second portions of the duodenum and the distal third of the stomach were resected. The severed ends of the duodenum and stomach could be approximated without tension, a Billroth No. 1 type of resection. A Levine tube was inserted beyond the stoma. (Fig. 1.)

Microscopically, all sections presented a similar appearance with a cytoplasmic and fibrillar reticulum. The cytoplasm was clear. The nuclei showed considerable variations in size, shape and tinctorial capacity. Multinucleated and giant forming cells were noted; mitoses were frequent; the nodules were composed of similar tissue.

Diagnosis: Myosarcoma with lymph node involvement. (Fig. 2.)

Postoperatively the patient developed a leakage at the stoma on the sixth day. Suction drainage was established from the depths of the wound. The patient was kept on parenteral

CASE II. No. 2411, Mrs. G. F., a white woman, age fifty-eight, was admitted to the Brooklyn Cancer Institute on January 14, 1946, complaining of intermittent vomiting of three months' duration. Cholecystectomy and appendectomy were performed in 1931. For one year she had had gaseous distress. Three months before admission she began to complain of nausea and vomiting after heavy meals. She was put on a light diet and amphojel with some relief; vomiting persisted. There was no history of abdominal pain; her appetite was good but she hesitated taking food for fear that she would vomit. There was no blood in the vomitus. The patient was not constipated and there was no evidence of blood in the stools. The radiographic examination two weeks prior to admission suggested the presence of partial obstructive neoplasm

in the proximal jejunum, approximately 4 inches from the ligament of Treitz.

Physical examination revealed a well developed female with heart and lungs essentially normal. There was a firmly healed, right rectus scar. A mass was palpable about 2 inches to the left of the midline midway between the costal margin and umbilicus. This was 2 inches to 3 inches in diameter, firm and partially fixed posteriorly although it had a range of mobility of 45 to 60 degrees. There was no apparent enlargement of the liver nor were there any supraclavicular nodes palpable.

Radiographic examination on January 18, 1946, revealed that the duodenum and the most proximal portion of the jejunum was dilated to three times its normal width and apparently came to a sudden stop just beyond the duodenojejunal junction. After several minutes the barium penetrated through a very fine channel approximately 2 inches long beyond which the jejunum again became visible. Two hours later the constricted area in the jejunum was clearly visible for approximately two inches. After six hours there was almost 50 per cent of the barium in the antrum and duodenum. (Fig. 3.)

Laboratory data are as follows: Gastric analysis on January 18th showed a faint trace of blood in the fasting specimen but none in three subsequent examinations. The free and total acidity was normal. The hemoglobin was 68 per cent, red blood cell count was 3,730,000, white cells 13,800, 64 per cent polymorphonuclear leukocytes, hematocrit 39 per cent, urea nitrogen 23.0 mg. per cent, sugar 129 mg. per cent, chlorides 460 mg. per cent, the total proteins 7.5 Gm. per cent, albumin 4.89 per cent and globulin 2.55 per cent. A provisional diagnosis was made of malignancy of the jejunum with partial obstruction. On January 21st a Levine tube was inserted and intermittent Wangensteen suction was established. During the next three days the patient received 4,000 cc. of amigen and 1,500 cc. of blood.

On January 23, 1946, under continuous spinal anesthesia and a transfusion the abdomen was opened through a midline incision. Two inches beyond the ligament of Treitz and intimately adherent to the transverse colon there was a mass approximately 8 by 5 by 5 cm., bluish purple in color, studded with white placques 1/16 inch to 1/4 inch in diameter, with marked foreshortening of the mesentery

FIG. 3. Case II. Roentgenogram showing dilated duodenum and most proximal portion of jejunum.

with several small mesenteric lymph nodes. (The lumen presented a cauliflower fungating appearance involving the entire circumference and causing almost napkin-ring constriction.) The disease process extended into all layers and there was one area 3/4 inch which was white and sclerotic. There was some dilatation of the proximal jejunum. There was no gross evidence of metastasis to the liver. The tumor was resected with the foreshortened mesentery beginning 1 inch from the ligament of Treitz to 3 inches beyond the lesion. The distal divided jejunum was closed with three layers of No. 1 silk sutures and an end-to-side anastomosis was established between the proximal jejunum and the distal jejunum. (Fig. 4.)

Microscopically, at the junction between normal mucosa and the neoplastic area a transitional zone was present. Individual cells lacked mucous globules, were elongated and contained long hyperchromatic nuclei. The papillary mass presented a similar picture although loss of normal polarity was more evident and there was invasion of the underlying tissue. The wall was widely invaded by nests of tumor cells which involved all the layers. Their appearance varied, the predominating feature being large areas of mucoid material within which were widely scattered small nests, rows and glands of columnar cells.

FIG. 4. Case II. Cut section of the ulcerating carcinoma of jejunum.
FIG. 5. Case II. Microscopic appearance of the gelatinous papillary carcinoma of the jejunum.

Many were distinctly mucous-secreting and signet ring forms were frequent. Other masses were in small solid sheets or cords; these cells were more uniform and embryonal in appearance. The lymph node was completely replaced by tumor tissue.

Diagnosis: gelatinous papillary carcinoma of jejunum. (Fig. 5.)

Postoperatively intermittent gastric suction was maintained for five days; amigen, blood, penicillin and intravenous sulfadiazine were given until the fifth day. The patient was discharged on February 6th with complete relief of symptoms. One month later symptoms recurred and she died April 8, 1946, two and a half months after the operation.

Comment. This patient had a carcinoma of the jejunum near the ligament of Treitz with an insidious onset of one year, acute symptoms of partial obstruction for three months, palpable tumor and radiographic diagnosis of an advanced lesion. The extensive tumefaction, lymph node involvement and extension of the disease into the foreshortened mesentery made impossible the complete radical extirpation of the rich bed of inaccessible lymphatics which was essential for a successful outcome.

CASE III. No. 121603, E. S., age forty-five, a white female was admitted to Beth Moses Hospital January 8, 1946, complaining of intermittent abdominal pain and vomiting of two weeks' duration. In September, 1944, she consulted a physician in Cleveland because of a loss of 10 pounds, progressive weakness, poor appetite, belching and heartburn. Her normal weight was 130 pounds. She never noticed blood in her stools nor did she complain of diarrhea or constipation. Her hemoglobin was 66 per cent. A gastrointestinal series suggested a gastric ulcer. She continued to get progressively weaker and returned to New York in December, 1945, with a hemoglobin of 32 per cent and weighing 100 pounds. On admission to the hospital she complained of intermittent vomiting of two weeks' duration, epigastric pain, gaseous distress, marked weakness, extreme pallor, constipation and occult blood in her stools.

The patient was acutely distressed and extremely pale. There were palpable cervical and axillary lymph glands. The heart and lungs were essentially negative. The abdomen was soft; there were no masses palpable. The hemoglobin was 8.5 Gm., red blood count 3,690,000, white blood count 10,750, 77 per cent polymorphonuclears. There was central achromia of the red cells. The urine was negative. The stool was positive for blood but no ova or parasites. Fractional gastric analysis revealed a free acid from 0 to 6 and total acidity 20 to 20 millimoles per cent, 3+ bile and blood 2+. The prothrombin was 31 seconds, prothrombin index 1.55. At this time the sugar was 125 mg. per cent, urea nitrogen 16 mg. per cent, chlorides 460 mg. per cent, cholesterol 210, ester 175, cephalin cholesterol flocculation negative; total proteins 5.25 Gm. per cent, albumin 2.59 per cent, globulin 2.61 per cent. Radiographic examination on January 17, 1946, at the end of six hours there was marked dilatation of the small intestine; the head of the advancing column of barium was in a distended sausage-
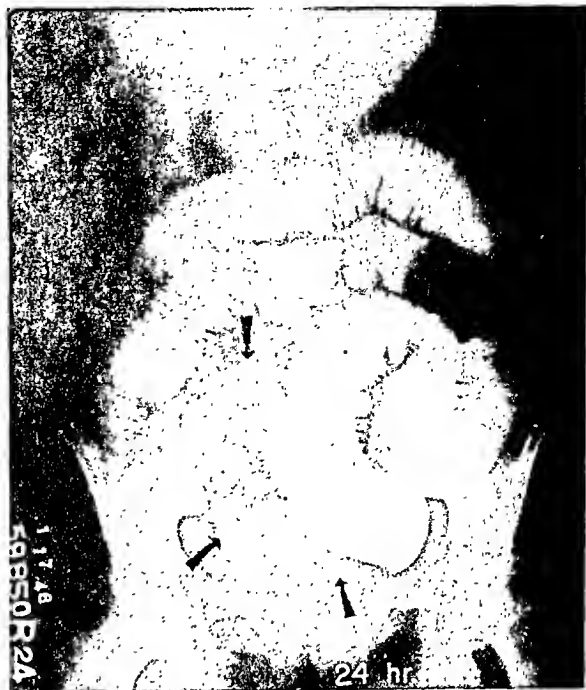
like ileum. At twenty-four hours the shadow contents assumed two parallel rows of distended jejunum with the left low ileal dip. There was noted a slow thin seepage of the shadow meal through ill defined lowest ileum. (Fig. 6.) At thirty hours there was very little change in arrangement of the loops of small intestine; some filling of the caput cecum was noted. At 120 hours the tip of the Miller-Abbott tube was in the lowest portion of the ileum above the point of obstruction which is about 1 foot from the cecum.

A Miller-Abbott tube with intermittent suction slightly relieved the distention. Repeated transfusions, amigen,' liver extract, vitamins B, C and K were given. The patient did not improve. Rigidity, distention and marked tenderness increased; the hemoglobin remained at a 32 per cent level.

Exploratory celiotomy was performed on January 22, 1946, under continuous spinal anesthesia and a transfusion through an inner right rectus incision. There was straw-colored fluid in the abdomen. About 18 inches from the ileocecal valve there was a purplish red semi-firm mass and distended small intestine approximately 8 inches long and 2 to 3 inches wide. This consisted of an obstructing tumor of the ileum and an intussusception. There were numerous large purplish mesenteric glands. The intestine and mesentery and glands were resected well beyond the tumefaction. The continuity was restored by an end-to-end anastomosis. (Figs. 7 and 8.)

The resected specimen measured 92 cm. of ileum; the proximal 28 cm. were markedly dilated and the distal 6 cm. were collapsed. The intervening 58 cm. consisted of a doughy elliptical mass measuring 19 cm. This was due to an intussusception. The proximal bowel was twisted through an angle of 180 degrees. When opened, 3 small masses, 2 to 3.5 cm. in diameter, were noted at its proximal line of intussusception and at its apex. These masses were firm in consistence and presented grayish-green discoloration on cross section. They were situated within the submucosal and muscular layers. The intussuscepted bowel presented a hemorrhagic appearance with considerable plastic exudate on its serosal surface.

Microscopically, the three masses presented a similar appearance consisting of polyhedral cells with clear, vacuolated or finely granular cytoplasm. The nuclei showed considerable

Fig. 6. Case III. At twenty-four hours the shadow contents assume two parallel rows of distended jejunum with the left low ileal dip. There is a thin seepage of the shadow meal through the ill defined lowest ileum.

atypism. Mitoses were numerous. Differential nerve and muscle stains were inconclusive.

Diagnosis: Sarcomas of the ileum; intussusception of ileum with hemorrhagic infarction and localized peritonitis. (Fig. 9.)

The immediate postoperative convalescence was uneventful. Flatus was expelled on the third day and a spontaneous evacuation occurred on the sixth day. After repeated transfusions she was discharged on February 10, 1946, with a hemoglobin of 11 Gm. and red blood cell count 4,120,000.

Five days after discharge from the hospital she was readmitted complaining of severe frontal headaches, nausea and vomiting of two days. The hemoglobin was 7.5 Gm., the red cell count 3,550,000. A Miller-Abbott tube was passed and intermittent suction reestablished. On February 23rd she had bilateral blurred optic nerves, a left central facial and more active tendon reflexes on the left Babinski. This was interpreted as an increased right intracranial pressure due to metastasis. In March nodules appeared under the skin almost over her entire body including her face. Biopsy of one of the skin nodules revealed metastatic sarcoma. In spite of repeated transfusions and supportive treatment the hemato-
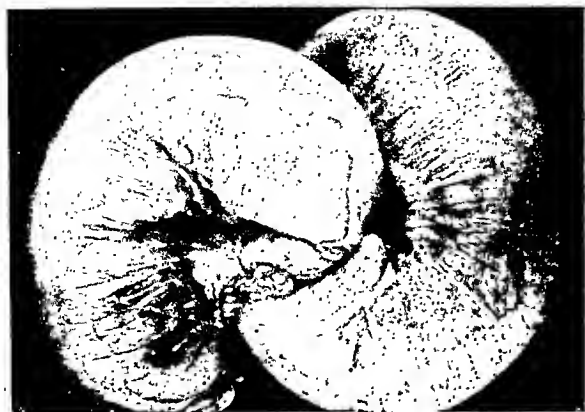
FIG. 7. Case III. Resected obstructed sarcoma of the ileum and intussusception.

FIG. 8. Case III. Sectioned intussusception revealing multiple tumors.

FIG. 9. Case III. Microscopic appearance of sarcoma of the jejunum.

crit on March 8th was 14 per cent and the chlorides 540 mg. per cent, total proteins 4.35 Gm. per cent. On April 8th the hemoglobin was 7.5 and the red cell count 2,460,000. Since her readmission she was disoriented except for short intervals and she became progressively weaker. She died in a coma on May 5, 1946.

Comment. This patient serves to illustrate treatment failure due to delay in diagnosis with resultant chronicity, severe anemia, extreme pallor, asthenia and

marked loss of weight. The manifold lesions included sarcoma of the small intestine, polyps, intussusception, perforation sealed off by an inflammatory exudate, cerebral and multiple skin metastasis.

CASE IV. No. 28936, D. B., a sixty-one year old white male, was admitted to the Brooklyn Cancer Institute on June 15, 1939, complaining of abdominal pain, weakness and loss of weight. For one year he had severe epigastric pain, usually occurring one and one-half hours after meals. The pain radiated around the abdomen to his back. He could get some relief with a lacto-fine vegetable diet or by belching. Six and two months before admission a gastrointestinal series were reported negative. He continued to complain of epigastric pain, progressive weakness and shortness of breath and for the last six months of a loss of 40 pounds. He stated that his stools were normal in color and consistency. In May, 1939, another gastrointestinal series in the clinic was reported negative. The stools were positive for occult blood. Physical examination disclosed a well developed chronically ill male showing evidence of recent weight loss. He weighed 158 pounds. Blood pressure was 132/90. The heart and lungs were essentially negative.

The abdomen was scaphoid and wrinkled. There was a freely movable irregular mass the size of an orange in the lower right quadrant. There was a persistent gurgling and tenderness over the mass. Sigmoidoscopic examination suggested an extrinsic mass approximately 9 cm. from the anus. The hemoglobin was 53 per cent, erythrocytes 3 million, the white cell count 7,850, the differential was normal;

the urea nitrogen 17 mg. per cent, sugar 118 mg. per cent. The urine was negative; occult blood was present in the stools. The Wassermann-Kline test was negative.

Gastrointestinal roentgenograms, the fourth in six months, fractional studies one, two, three and four hours revealed the ileum filled with barium. Seven hours after the meal most of the meal was in the colon. It was noted that the small intestine was found at all times above the pelvic cavity as though it was pushed upward. The barium enema suggested a mass in the pelvic cavity pressing on the bladder and sigmoid. The small intestinal studies suggested a large mass pressing on the ileum about 15 cm. from the cecal valve. (Fig. 10.) Intravenous pyelogram of the kidneys was negative but showed a shallow impression in the upper portion of the bladder suggesting a mass above the bladder.

Because of the persistence of pain, loss of weight, the presence of blood in the stools, a palpable movable mass, with negative intrinsic radiographic reports, a presumptive diagnosis was made of an extrinsic carcinoma which may have ulcerated into the bowel. Surgical intervention was advised.

Exploratory celiotomy was performed on June 26, 1939, under spinal anesthesia. There was a firm, rubbery and nodular mass in the pelvis approximately 10 cm. in diameter involving the ileum and its mesentery close to the posterior abdominal wall. About 4 inches of the ante-mesenteric portion of the sigmoid was attached to the ileum and its mesentery. There were two small white placques about 1 cm. in diameter on the serosal surface of an adherent portion of ileum. The involved ileum and sigmoid were resected, including 8 inches of the former and 4 inches of the latter. The two white placques on the ileum were excised. The continuity of the ileum was restored by a side-to-side anastomosis approximately 12 cm. from the ileocecal valve. The clamped distal and proximal loops of the sigmoid were approximated with fine silk. (Figs. 11 and 12.)

The specimen consisted of 22 cm. of ileum; the central portion was acutely kinked. Attached to the wall at this point and involving all its layers was a soft, yellowish multilobular mass 13 by 9 by 8 cm. ulcerating the mucosa for 4 cm. at the point of angulation. The opposite end of the mass was adherent to a section of large intestine reaching its muscularis. The

FIG. 10. Case IV. Roentgenogram showing partial obstruction and upward displacement and fixation of intestine.

large bowel mucosa presented a polyp 0.3 cm. in diameter. Two peritoneal nodules 0.8 cm. in diameter were firm and homogenous white on cut section. The microscopic examination disclosed a mass composed of sheets of tumor cells in wide bundle arrangement. The cells were spindle in type, with vesicular or hyperchromatic nuclei. Regular mitotic figures and giant forms were common. The ulcer bed was covered by a fibrino purulent layer. The tumor invaded the serosa of the sigmoid. The peritoneal nodules consisted of similar tumor tissue. The colonic polyp was benign epithelial.

Diagnosis: Leiomyosarcoma of small intestine with extension to the colon and peritoneum. (Fig. 13.)

The post operative convalescence was complicated by urinary difficulty for fourteen days. The proximal clamp was removed on the fourth day, a crushing clamp was applied to the sigmoid spur on the fourteenth day and removed nine days later. The colostomy was closed extraperitoneally thirty-five days after the resection. He was discharged from the hospital sixty-one days after the resection having gained considerable weight.

The patient returned to the follow-up clinic. When seen on November 14, 1939, he had gained 20 pounds and weighed 182 pounds.

FIGS. 11 and 12. Case IV. Gross and cut section of leiomyosarcoma of ileum and sigmoid.

There was, however, evidence of a mass in his abdomen. He was given x-ray therapy. Radiographic examination one hour after a barium meal failed to reveal any obstruction in the course of the small intestine; the head of the barium had reached the cecum; the area of the resection and anastomosis was demontrated by diminished filling and other loops of small intestine above and below this area were encroached by adjacent masses.

The patient received several courses of deep x-ray therapy but gradually became weaker and continued to lose weight and his abdomen became markedly distended. Several masses were felt in his abdomen; they gradually became larger and caused him considerable distress. He expired August 21, 1940, fourteen months after the operation and probably two years after the onset of his symptoms.

Comment. This patient had a protracted history of vague intestinal symptoms and illustrated the difficulty in detecting early signs of disease or interpreting early roentgenograms. Three gastrointestinal series within six months were reported negative. A large tumor of the ileum was present invading the colon and lymphatics and implanting itself on adjacent ileum. This patient had severe anemia, asthenia, prostration and partial obstruction for a long time before acute obstruction late in the disease prompted intervention. Early recurrence was inevitable because of the difficulty of completely extirpating the disease and all of the lymphatics. The disease was resistant to deep therapy.

Incidence. The tumor is comparatively rare, the literature containing only individual or small group case reports.[1-9] Ewing[10] states that malignant tumors of the small intestine comprise about 3 per cent of all malignancies of the gastrointestinal tract. Ficarra and Marshall[11] reported that on the basis of surgical specimens and autopsy material, small intestinal carcinoma has a reported incidence varying from 0.46 per cent to 6 per cent of all gastrointestinal cancers. They noted that twenty-nine cases had been seen in the Lahey clinic in thirty years. Horsley[12] reviewing the literature from Raiford's[3] contribution in 1932 to January 1, 1941, found 384 cases of carcinoma and carcinoid of the jejunum and ileum; of these 236

were adenocarcinoma of the jejunum or ileum. Eger[5] collected 304 primary carcinomas of the duodenum and found 62 per cent in the second part, 24 per cent in the first part, 12 per cent in the third part and 2 per cent involving the entire duodenum and called attention to the duodenum being affected in 45 per cent of instances of primary carcinoma of the small intestine. Hoffman and Pack[13] in 1937 reported 238 cases of small intestinal carcinoma of which 45.6 per cent was in the duodenum. Fraser[14] reported thirteen cases, six carcinoma and seven sarcoma, among 22,975 operations on the gastrointestinal tract and 2,674 autopsies from the Western Infirmary, Glasgow, over a ten-year period.

In 1945 Shallow, Eger and Carty[15] reported a case of primary adenocarcinoma of the mid-jejunum and reviewed thirty-eight consecutive cases of histologically proven primary malignancy of the small bowel in the Jefferson Medical College Hospital. They made an exhaustive study of intestinal malignancies among 137,174 general autopsies collected from the literature from 1858 to 1938 and tabulated 5,034 in the large and 134 in the small intestine. This is an incidence of small intestinal malignancies of 0.1 per cent or about thirty-six times less frequent than large intestinal carcinoma. They listed the frequency of small intestinal malignancies among general intestinal malignancies and found that 3 per cent of intestinal carcinoma and 60 per cent of intestinal sarcomas occur in the small intestine. In surveying the incidence and distribution of carcinoma and sarcoma among primary small intestinal malignancies they tabulated 269 cases including their own thirty-eight. They found seventy-three carcinoma and twelve sarcoma in the duodenum; seventy-five carcinoma and twenty-one sarcoma in the jejunum; and thirty-eight carcinoma and fifty sarcoma in the ileum, e.g., 186 carcinoma and eighty-three sarcoma. They concluded that carcinoma is twice as common as sarcoma and that
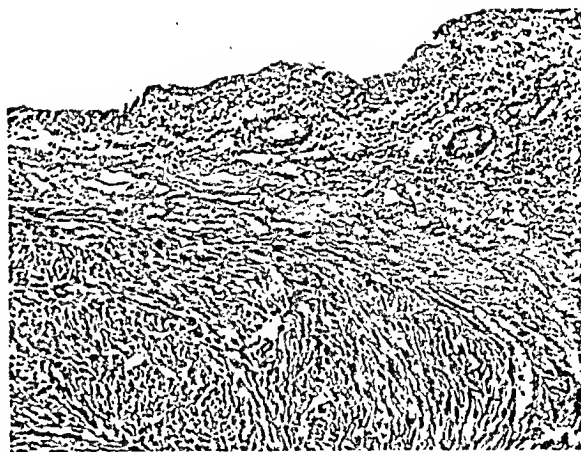
Fig. 13. Case IV. Microscopic appearance of leiomyosarcoma of ileum and sigmoid.

malignancy in general occurs with equal frequency in all three divisions of the small intestines, the ileum ranking lowest for carcinoma but highest for sarcoma. Ehrlich and Hunter[16] in a survey of 813 tumors arising in army personnel between eighteen and thirty-eight reported nine cases of primary carcinoma of the small intestine; eight of them were adenocarcinoma and one was a mucous cell carcinoma. Two arose in the duodenum, four in the jejunum and three in the ileum.

"Carcinoid" and the extremely rare type of melanocarcinoma of the small intestine are not included in this survey. Readers are referred to Dickson Parkhill and Kiernan's[17] paper in 1946 wherein they state that carcinoid tumors constitute a third of all malignant neoplasms of the small bowel and occur twice as frequently in the appendix than in the small bowel. They attribute to Oberndorfer the term "carcinoid" to express their malignant appearance in contrast to their benign course.

Pathologically, malignant tumors of the small intestine have been classified as (1) a stenosing napkin-ring like and constricting; (2) infiltrating—ulcerating, bulky, fungating and gelatinous papillary, and (3) polypoid, single or multiple and fungating. All three categories may be found in one case. With few exceptions malignant tumors of the small intestine begin as adenocarcinoma although medullary, scirrhous and colloid carcinoma have been reported. Sarcoma

may grow asymmetrically into the mesentery or into the peritoneal cavity (Case 1) or readily become adherent and directly implant themselves into other viscera as in the colon (Case IV). Characteristically they generally grow circumferentially around the bowel wall, gradually occluding the lumen causing obstruction by cicatricial contracture. In rare instances the polypoid group, single or multiple, may be responsible for precipitating intussusception as portrayed in Case II. Kiefer and Lahey[4] believe that intussusception occurs in 30 per cent of tumors of the lower jejunum and ileum.

Malignant intestinal tumors arising from muscle are comparatively infrequent. Most writers consider all leiomyomas as benign and designate malignant tumors of the muscle as leiomyosarcoma. Klopp and Crawford[7] were able to find eighteen cases, thirteen were designated as occurring in the jejunum; four of these showed evidence of metastasis. They apparently develop slowly with a tendency to grow in bulk, degenerate and form cysts. Significantly they seldom occlude the lumen. They may extend outward into the mesentery crowding the visceral peritoneum and may attain an enormous size thus producing pressure on adjacent structures. X-ray may be of little value unless the tumor encroaches on the lumen. This description coincides with the gross findings in Case I. Most of Klopp and Crawford's[7] cases were known to arise from the longitudinal muscle coat and others from the circular layer. Most of them were firm, nodular and prone to degenerate. Harrington[18] in reporting a case of leiomyosarcoma of the duodenum observed that so few cases of primary sarcoma of the duodenum have been reported that it is impracticable to attempt to draw any conclusions regarding their pathologic pattern.

Small intestinal carcinoma metastasizes early; usually there is prompt extension and metastasis to the mesentery, regional lymph nodes, peritoneum, liver, lungs, brain, bone and skin. In Case III there was clinical evidence of metastasis to the brain and extensively generalized subcutaneous metastasis within a few weeks after resection. The direct extension into the mesentery so characteristically foreshortens the mesentery that effective radical excision of the disease is precluded. This accounts for the early recurrence.

Clinical Features. Tumors of the small intestine usually manifest themselves so insidiously that in their early formative stage they may mimic less serious gastrointestinal diseases. In most instances the patients present themselves with signs and symptoms of partial or complete obstruction of several days or weeks' duration. Frequently a history is elicited of vague, long-standing intermittent abdominal distress and fullness. There is a reluctance to eat because of the intestinal distress and distention that ensue. Nausea, weakness, asthenia, fatigue and loss of weight become increasingly more apparent. Occult blood may be detected in the stools. There is usually severe anemia from inadequate ingestion and absorption of food, absorption of toxic products of the carcinoma and loss of blood.

As the growth encroaches on the lumen and there is interference with the motility of the intestine and absorption of food, these symptoms become more acute. Severe intermittent pain, increasing nausea, vomiting and distention, and the classical symptoms and signs of intestinal obstruction become more evident as the disease progresses from partial to complete obstruction. As a result of the loss of fluid in the vomitus and into the distended bowel, there is a fall in blood chlorides, a rise in the non-protein nitrogen, some degree of alkalosis, dehydration and prostration. These findings become irreversible unless actively combated and the obstruction is relieved.

Not infrequently there is a history that the symptoms one or several months prior to admission prompted gastrointestinal x-ray studies which were variously diagnosed. Small intestinal fractional studies in early cases are notoriously difficult to

interpret. The more proximal the malignancy the sooner and more distressing the complaints and the more readily are the radiographic manifestations recognized. When the disease is complicated by intussusception as in Case III, the acute crisis necessitates immediate surgical intervention.

In the extrinsic malignant tumors the diagnosis is even more difficult and is rarely made preoperatively. Not until the expanding tumor encroaches on the lumen and adjacent structures or the effects of the ulcerating lesion. demands operative interference, is the true nature of the disease ascertained. In a case of leiomyosarcoma of the duodenum, reported by Harrington, a woman thirty-eight years old, eight months before consultation at the Mayo Clinic, noticed generalized weakness and her physician recognized the anemia; three months later she had to relinquish her occupation as a school teacher. On admission to the clinic the hemoglobin was 38 per cent and erythrocytes 2,200,000. A stasis roentgenogram of the small bowel disclosed a flat polypoid type of lesion situated at the junction of the second and third portions of the duodenum, with an apparent central region of depression or ulceration. A diagnosis of a chronic bleeding lesion of the third portion of the duodenum was made. It was only after opening the abdomen that the true nature of the disease was determined. The history of Case I is somewhat similar. For five months he had increasing weakness. He was treated in another institution for duodenal ulcer. It was the progressive weakness and pain which ultimately necessitated surgical intervention and the true nature of the disease was ascertained, i.e., an extrinsic leiomyosarcoma of the duodenum.

The prognosis is grave because (1) the disease is rarely recognized before late manifestations have developed; (2) the roentgenologic diagnosis is difficult to establish in the early stages of the disease. Instances of early repeated negative interpretation of fractional small intestinal

studies are recorded only to be diagnosed when the disease has advanced to the stage of partial or complete obstruction; (3) operation invariably discloses that the malignant process has invaded the lymphatics and resulted in a foreshortening of the mesentery; (4) the invasion of the rich lymphatics in the inaccessible upper segments of the mesentery results in early wide-spread metastasis and (5) radical extirpation of the diseased segment of the bowel and restoration of its continuity, while technically successful, is doomed to failure. Extirpation of the mesentery, which is foreshortened by the disease and the inaccessibility of the involved lymphatics, precludes a successful outcome as the disease has inevitably extended beyond the confines of the mesentery.

SUMMARY AND CONCLUSIONS

Four cases of malignant tumors of the small intestine have been presented. The underlying morbid process was different in each case. They illustrate the difficulty in early recognition and the reasons for the grave prognosis: (1) The early symptoms are vague intermittent abdominal distress and distention bearing no relation to meals; followed by progressive weakness and severe anemia; (2) radiographically early, the disease is variously diagnosed and a correct radiographic interpretation is rarely made before the onset of partial obstruction; (3) with the onset of obstruction the disease is generally too far advanced to achieve a successful outcome; (4) the disease frequently extends to the mesentery which is foreshortened; the lymphatic spread precludes radical extirpation of the inaccessible lymphatics; (5) metastasis and early recurrence within a few weeks to two years is to be expected if thorough extirpation of involved lymphatics cannot be effected; (6) the disease is resistant to radiotherapy.

Extirpation of malignant tumors of the small intestine, even in advanced stages, is attended with a relatively low immediate

operative mortality, therefore, earlier recognition of the disease may enhance the ultimate result. This may possibly be accomplished by (1) close evaluation of the history, (2) improvement in radiographic studies in order to ferret out the early intra- or extraluminary encroachments and (3) comprehensive repeated laboratory investigations particularly for occult blood in the stools and significant physiochemical changes in the blood in other than readily diagnosed entities.

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DOES THE BOWEL PREVENT THE OUTWARD DIFFUSION OF GAS FROM WITHIN THE BALLOON OF INTESTINAL TUBES?

AN EXPERIMENTAL STUDY

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IT has been unquestionably established that balloons of intestinal decompression tubes are permeable to intestinal gases.[1] Although we have developed a method of tying on the balloon of intestinal tubes so as to prevent the accumulation of gas within the balloons of intestinal tubes, cases are being reported in which, because of an error in applying the tie or as a result of a knot in a Miller-Abbott tube, a considerable distention of the balloon occurs. Several fatalities have been reported[2,3,4] because the surgeon failed to realize the significance of an increase in gas within the intestinal tube balloons or did not know how to contend with this complication.

In our studies upon the permeability of intestinal balloons to carbon dioxide gas and hydrogen sulfide gas we were able to show *in vitro* that if the bowel circumjacent to the balloon is decompressed, the gas within the balloon would diffuse out. The diffusion outward of the hydrogen sulfide is very rapid, occurring in a matter of minutes. Carbon dioxide, although it diffuses out much slower, will nevertheless completely diffuse out of balloons exposed to the air in less than twenty-four hours. Since these studies were carried out *in vitro* by exposing the balloons to atmospheric air and since only carbon dioxide and hydrogen sulfide were used, the question arose as to whether the same findings would hold true for balloons within the intestinal tract and for balloons filled with air.

The great importance of such studies is quite apparent in that we would then be in a position to tell the surgeon with a definite degree of certainty just what to expect when roentgenograms disclosed a balloon distended with gas. Very often the first indication that the surgeon has that something unusual has occurred is the cessation of suction decompression in the case of the Miller-Abbott tube or the inability on the part of the surgeon to remove the Harris intestinal decompression tube.[5]

This experimental study was divided into four parts and an effort made to reproduce *in vivo* conditions as closely as possible.

METHOD

Experiment No. 1. This experiment has as its purpose to show the effect of fluid in contact with the balloons of intestinal tubes upon the permeability of the balloons to various gases. Twelve balloons were used in this study. The volume of gas in the balloon was measured by the water displacement method.

Air-filled Balloons

		cc.
1.	Cantor balloon (latex)	22
2.	Cantor balloon (neoprene)	35
3.	Harris balloon	117
4.	Miller-Abbott balloon	61

Carbon Dioxide-filled Balloons

1.	Cantor balloon (latex)	33
2.	Cantor balloon (neoprene)	64
3.	Harris balloon inflated	254
4.	Miller-Abbott balloon	90

Hydrogen Sulfide-filled Balloons

1.	Cantor balloon (latex)	17
2.	Cantor balloon (neoprene)	47
3.	Harris balloon inflated	182
4.	Miller-Abbott balloon	64

These balloons were then submerged in shallow pans containing water. The balloons were completely covered by the

water. Seven thousand cc. of water at 13°C. were used in each pan. Three pans were used, one for each group of four balloons. At the end of three hours all the balloons were examined and then at the end of twenty-four hours all the balloons were re-examined.

RESULTS

At the End of Three Hours. At the end of three hours the results were as follows:

Air-filled Balloons

		cc.
1. Cantor balloon (latex)	....	22
2. Cantor balloon (neoprene)	....	35
3. Harris balloon	....	117
4. Miller-Abbott balloon....	....	61

A comparison of these values at the end of the three-hour period with those at the beginning of the experiment shows no loss of air from any of the balloons.

Carbon Dioxide-filled Balloons

		cc.
1. Cantor balloon (latex)	....	3
2. Cantor balloon (neoprene)	....	53
3. Harris balloon	....	24
4. Miller-Abbott balloon	....	6

A comparison of these values with those at the beginning of the experiment shows a considerable loss of carbon dioxide from all the latex balloons but only a small loss from the neoprene balloon. The actual loss of carbon dioxide gas from each balloon is as follows: Cantor latex balloon showed a loss of 30 cc. or 90 per cent of its gas; Cantor neoprene balloon showed a loss of 11 cc. or 17 per cent of its gas; Harris balloon showed a loss of 230 cc. or 90 per cent of its gas; Miller-Abbott balloon showed a loss of 84 cc. or 93 per cent of its gas.

Hydrogen Sulfide-filled Balloons

		cc.
1. Cantor balloon (latex)	....	3
2. Cantor balloon (neoprene)	....	28
3. Harris balloon	....	8
4. Miller-Abbott balloon	....	8

A comparison of these values with those at the beginning of the experiment shows a marked loss of hydrogen sulfide gas from all the latex balloons but again only a small loss from the neoprene balloon. The actual loss of hydrogen sulfide gas from each balloon is as follows: Cantor latex balloon showed a loss of 14 cc. or 82 per cent of its gas; the Cantor neoprene balloon showed a loss of 19 cc. or 40 per cent of its gas; the Harris balloon showed a loss of 174 cc. or 95 per cent of its gas; the Miller-Abbott balloon showed a loss of 56 cc. or 87 per cent of its gas.

At the End of Twenty-four Hours. At the end of twenty-four hours all these balloons were re-examined. It was now found that all the balloons filled with air had lost no gas. The balloons filled with hydrogen sulfide and those filled with carbon dioxide were found to be completely empty.

These results when compared with our previous studies[6] upon the diffusion of gases from within the balloons when exposed to air show essentially the same speed of loss of the various gases. It is thus evident that the submersion of the balloons in water does not in any way change the speed of diffusion of the various gases. It must also be noted that within the twenty-four-hour period there was no diffusion of the air-filled balloons through the walls of the balloon. This observation is important in the light of the many observations that air can be found within the balloons of intestinal tubes as well as the fact that in the Miller-Abbott tube the balloon is deliberately filled with air for the purposes of propulsion. The presence of a safety valve by tying the balloons on over a 22 French stylet in a Cantor tube of 18 French luminal diameter would effectively prevent this occurrence since the air could readily escape through the vent that was left when the stylet was removed after the application of the tie was completed.

Experiment No. 2. This experiment had as its purpose to show the effect of the close approximation of the human bowel wall to the distended balloon upon various gases trapped within the balloon. Ten balloons were used in this experiment. The balloons were divided into three groups. The first

group of four balloons were filled with air, the second group of three balloons were filled with carbon dioxide and the third group of three balloons were filled with hydrogen sulfide gas. All balloons were carefully sealed after being filled to prevent loss of gas from the mouth of the balloon. Each group was then inserted into a 12 inch length of small intestine taken from a human autopsy one hour previously. The bowel wall was markedly distended by the inflated balloons so that a very close approximation between the balloons and bowel wall obtained. The ends of the bowel were then tied off and the sections of bowel submerged in a pan containing 7,000 cc. of normal saline at 13°C. Three pans were used for this purpose, each group being kept in a separate pan.

Air-filled Balloons

	cc.
1. Cantor neoprene balloons	36
2. Cantor latex balloons	23
3. Harris balloon	119
4. Miller-Abbott balloon	64

Carbon Dioxide-filled Balloons

1. Cantor neoprene balloon	26
2. Harris balloon	125
3. Miller-Abbott balloon	53

Hydrogen Sulfide-filled Balloons

1. Cantor neoprene balloon	27
2. Harris balloon	76
3. Miller-Abbott balloon	41

RESULTS

At the End of Three Hours. All the air-filled balloons, Cantor neoprene, Cantor latex, Harris and Miller-Abbott showed no change at the end of three hours. It is obvious from this examination that there has been no outward diffusion from within any of the balloons.

Carbon Dioxide-filled Balloons

	Per cent of Gas Remaining
1. Cantor neoprene balloon	75
2. Harris balloon	25
3. Miller-Abbott balloon	25

Here again we see that the Cantor neoprene balloon has lost only one-fourth of its gas whereas the latex Harris balloons and the latex Miller-Abbott balloons have lost three-fourths of their gas. This is a definite

index of the comparative permeabilities of neoprene and latex.

Hydrogen Sulfide-filled Balloons

	Per cent of Gas Remaining
1. Cantor neoprene balloon	50
2. Harris balloon	25
3. Miller-Abbott balloon	25

The water in which this segment of bowel was immersed had become milky like that in which the hydrogen sulfide-filled balloons without the bowel had been immersed. It is evident that the hydrogen sulfide gas diffuses rapidly not only through the balloons but also through the bowel wall. Again the neoprene balloon is seen to be much less permeable than the latex balloons.

At the End of Twenty-four Hours. At the end of twenty-four hours the air-filled balloons had shown no loss of air. The carbon dioxide and the hydrogen sulfide gas-filled balloons had lost all their gas and were now found to be empty.

Experiment No. 3. This experiment had as its purpose to show the effect of the close approximation of the human bowel containing intestinal contents taken from a case of bowel obstruction upon the outward diffusion of gases trapped within the balloons of intestinal tubes. In this experiment the inflated balloons were tied off, and then inserted into 12 inch lengths of human small intestine taken from a one hour old autopsy. Three sections of human bowel were used in this experiment. The distended balloons caused a marked stretching of the bowel wall which closely approximated the balloon. The bowel was then filled with intestinal secretion taken from a case of bowel obstruction. Since we had amply demonstrated that the outward diffusion of air was negligible in the twenty-four hour period, we decided to omit the air-filled balloons in the experiment. We used only Harris balloons and neoprene Cantor balloons because the behavior of the Harris latex balloon is exactly the same as that of the latex Miller-Abbott. Since the Cantor latex balloon is now re-

placed by the Cantor neoprene balloon, we decided to use the new Cantor neoprene balloons.

Carbon Dioxide-filled Balloons

	cc.
1. Harris balloon filled	90
2. Cantor neoprene balloon	26

Hydrogen Sulfide-filled Balloons

| 1. Harris balloon | 92 |
| 2. Cantor neoprene | 33 |

RESULTS

At the End of Three Hours. At the end of three hours the results were as follows:

Carbon Dioxide-filled Balloons

1. Harris balloon............. 50% of gas remaining
2. Cantor neoprene balloon.... 90% of gas remaining

A comparison of these values with those at the beginning of the experiment demonstrates rather conclusively that the neoprene under these conditions is much less permeable than the latex.

Hydrogen Sulfide-filled Balloons

1. Harris balloon............. 25% of gas remaining
2. Cantor neoprene balloon.... 75% of gas remaining

Here again we note that hydrogen sulfide is much more diffusible than was the carbon dioxide, and that the neoprene balloon is far less permeable than the latex.

At the End of Twenty-four Hours. All the balloons containing carbon dioxide and hydrogen sulfide gas were found to be completely empty.

Experiment No. 4. The purpose of this experiment was to determine whether intestinal secretions alone could cause gas to diffuse into balloons of intestinal tubes. For this experiment 400 cc. of intestinal contents removed from a case of bowel obstruction was used. Two balloons containing mercury were tied off and then submerged in this juice for twenty-four hours and examined for gas.

Results. An examination of the balloons at the end of twenty-four hours showed no gas within the balloons. An examination at the end of forty-eight hours had similarly shown the balloons to be empty.

SUMMARY

The effect of submersion of balloons of intestinal decompression tubes inflated with different gases in water was studied and compared with similar studies in which the inflated balloons were exposed to air. The experiment indicated that there was very little or no difference in the speed of diffusion of the gases from within the balloons exposed to air or submerged in water. In reproducing *in vivo* conditions the inflated balloons were inserted within the intestinal tract of an hour-old autopsy specimen. The inflated balloon caused the bowel wall to be stretched tightly over it. We noted that the speed of diffusion of the gases out of the balloons was the same whether the bowel was empty or filled with intestinal secretions. There appeared to be very little difference between the speed of diffusion of gases out of the balloons within the bowel or those submerged in liquid or exposed to air.

This experimental study clearly shows that if an intestinal decompression tube balloon becomes inflated as a result of carbon dioxide or hydrogen sulfide, the passage of a second intestinal tube to decompress the circumjacent bowel would rapidly result in the diffusion of the hydrogen sulfide or the carbon dioxide from within the balloon into the bowel. The speed of diffusion of the hydrogen sulfide is so fast that it is extremely doubtful whether this gas enters into the problem at all. The only possible influence this gas might have is suggested by our observations that balloons filled with hydrogen sulfide rapidly lost this gas in less than four hours. If then these balloons were permitted to lie exposed to the air, they took up some of the air. This diffusion of air into balloons formerly filled with hydrogen sulfide might constitute a real problem in intubation, or the presence of an air-filled Miller-Abbott balloon which could not be evacuated as a result of a knot in the tube might be quite serious for the patient. The reason for this is obvious from our observations, that the air-filled balloons showed very little or no change in twenty-four hours. Some balloons filled with air were observed for four days and were then noted

to show very little if any loss of air. When we recall that approximately 80 per cent of the air consists of nitrogen, a gas which is extremely slowly diffusible through a rubber membrane, it becomes obvious why this should be so. Once air has accumulated within the intestinal tube balloons many days of bowel decompression are required before any appreciable loss of air occurs from the balloon. The best treatment for this unusual accident is to prevent it by the use of a No. 18 French lumen tube and a safety valve vent as described in an earlier publication.[1]

CONCLUSIONS

1. The speed of outward diffusion of hydrogen sulfide and carbon dioxide from within the balloons of intestinal decompression tubes is not influenced by the media in which they occur. Exposure to air, submersion in water, insertion within the empty bowel or insertion within the bowel filled with intestinal secretion does not result in any change in the speed of diffusion of the gas under the same conditions of temperature and pressure.

2. Hydrogen sulfide gas is most rapidly diffusible from the balloons, so much so in fact, that it is highly improbable that this gas is a factor in this problem.

3. Neoprene balloons are far less permeable than are latex balloons.

4. Submersion of balloons containing mercury in intestinal secretions for twenty-four hours does not result in any gas intake.

5. The best treatment for this complication is prevention. Should this accident occur, adequate decompression of the bowel will generally result in the inflated balloon losing sufficient air so that it can be excreted per rectum.

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FURTHER STUDY OF THE SUSPENSORY MUSCLE OF THE DUODENUM*

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A REPORT was made previously[1] of a study of the suspensory muscle of the duodenum in seventy-seven cadavers. In this work we attempted to determine the attachments of this structure, especially its precise attachments to the duodenum. We also attempted to determine the percentage of instances in which muscle tissue could be demonstrated in it and to determine what kind of muscle it was.

By gross examination we found that in 5.2 per cent of the specimens the fibers were attached solely to the duodenojejunal flexure; in 61 per cent they were attached to the flexure and to the fourth and third parts of the duodenum, and 15.6 per cent they were attached to the fourth and third parts of the duodenum with no attachments to the flexure. In 18.2 per cent of the specimens this structure could not be demonstrated.

In 31.2 per cent of the specimens muscle fibers appeared to be present from gross examination while in 50.6 per cent one could not determine whether or not muscle fibers were present.

By microscopic examination we found muscle fibers present in 90 per cent of the specimens in which they appeared to be present by gross examination, and in 80' per cent of the specimens in which it could not be determined by gross examination whether or not they were present. In all cases we found the muscle tissue to be of the smooth type.

Purpose of Present Study. In this series of specimens we have continued the study that was made in the previous series. In the previous study, however, only a qualitative examination was made while in this one both qualitative and quantitative estimations were made, and the qualitative study was made in much more detail.

Procedure. Grossly, the muscle, (or ligament), in sixty-four human cadavers was cleaned, measured and removed with the duodenum after noting carefully the origin and insertion. Careful examination was made to determine whether or not muscle fibers could be detected grossly.

RESULTS

Gross Findings. In fifty-seven (89 per cent) of our specimens, either a muscle or a ligament could be definitely demonstrated while in seven (11 per cent) neither could be found.

Attachment of the structure to the duodenum can be tabulated as follows in Table 1:

TABLE I

	No.
Attached to flexure only and with muscle fibers apparent...	1
Attached to flexure only and with no muscle fibers apparent..	4
Attached to flexure and to 3rd and 4th parts of duodenum and with muscle fibers apparent.....	14
Attached to flexure and to 3rd and 4th parts of duodenum and with no muscle fibers apparent	10
Attached to flexure and to 2nd, 3rd and 4th parts of duodenum and with muscle fibers apparent.....	4
Attached to flexure and to 2nd, 3rd and 4th parts of duodenum and with no muscle fibers apparent...	4
Attached to 3rd and 4th parts of duodenum only and with muscle fibers apparent...................	11
Attached to 3rd and 4th parts of duodenum only and with no muscle fibers apparent...............	9

From the above tabulation it can be seen that in only five (8.8 per cent) of these
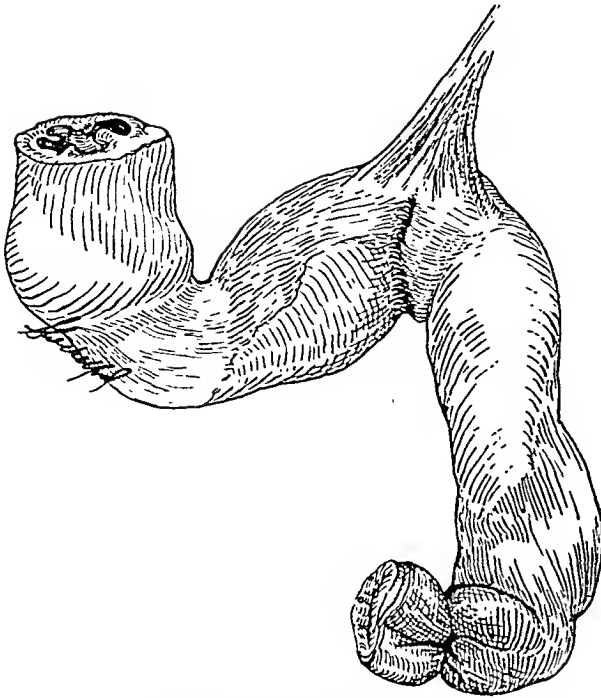
FIG. 1. Drawing showing attachment of the suspensory muscle to the duodenojejunal flexure; specimen No. 5.
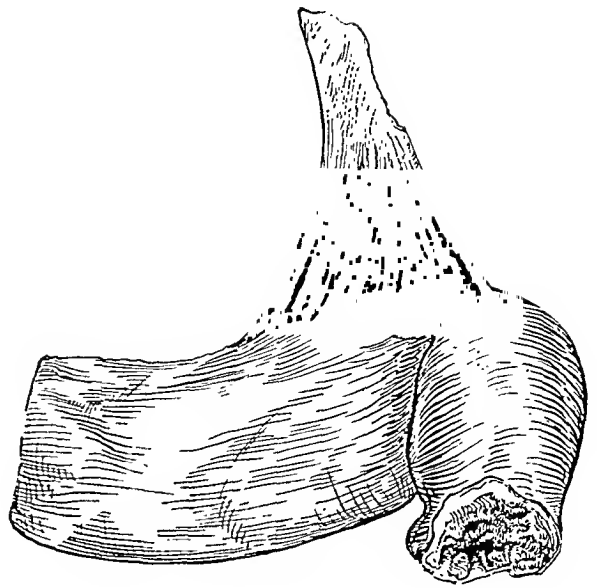
FIG. 2. Drawing showing attachment of the suspensory muscle to the fourth part of the duodenum and the duodenojejunal flexure; specimen No. 42.
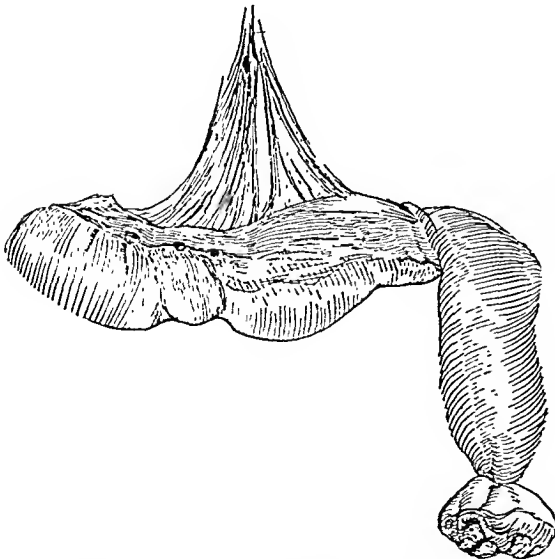
FIG. 3. Drawing showing attachment of the suspensory muscle to the third and fourth parts of the duodenum; specimen No. 19.
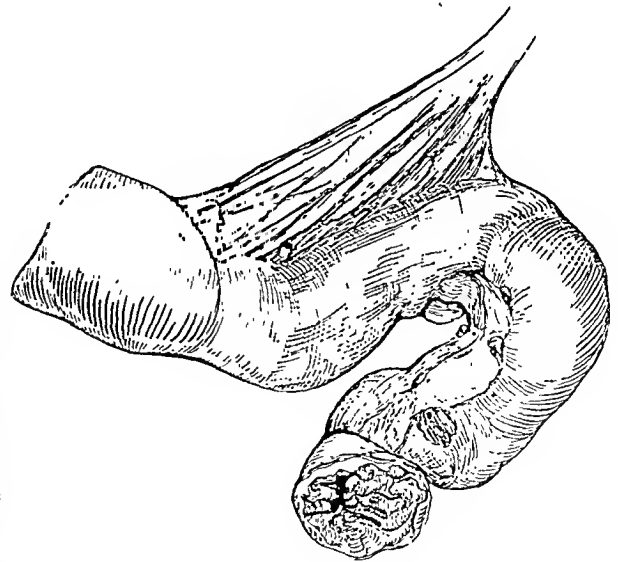
FIG. 4. Drawing showing attachment of the suspensory muscle to the second, third and fourth parts of the duodenum; specimen No. 28.

FIG. 5. Photomicrograph of a transverse section of the suspensory muscle of the duodenum showing scattered fascicles of smooth muscle enmeshed in loose connective tissue; specimen No. 46; Van Gieson's stain; × 100.

FIG. 6. Photomicrograph of a longitudinal section of the suspensory muscle of the duodenum showing smooth muscle cells; specimen No. 7; hematoxylin-eosin stain; × 900.

specimens in which a definite anatomic structure could be demonstrated was this structure attached to the flexure only, while in fifty-two (91.2 per cent) it was attached to either the second, third or fourth parts of the duodenum or to combinations of these parts. (Figs. 1 to 4.)

Likewise, it can be seen that in thirty (52.6 per cent) of the specimens in which a definite anatomic structure could be demonstrated muscle fibers were apparent grossly, while in twenty-seven (47.4 per cent) it could not be determined grossly whether or not muscle fibers were present. The length of the structure was usually found to be 7 to 11 cm.

MICROSCOPIC STUDY

Microscopic Methods. Histologic preparations were made of fifty-five of the fifty-seven dissected specimens. Following embedding in paraffin and sectioning at 10 micra (largely transversely but in a few instances longitudinally), each fifteenth consecutive section was mounted and stained with Delafield's hematoxylin and eosin. In order to reduce any error in the differentiation of muscle and collagenous tissue six of the specimens were stained with Van Gieson's method. Selected sections of eleven specimens were stained with MacCallum's elastic tissue stain so as to check for the presence of elastic tissue. In

several instances microprojection tracings of the smooth muscle and connective tissue components were made and the cross sectional areas measured with a planimeter. In this manner reasonably exact ratios of these two types of tissue were established.

Microscopic Study. Histologic preparations have shown that we are dealing with a structure composed of smooth muscle and loose connective tissue. (Figs. 5 and 6.) The ratio of these two principal components has been found to be variable, both as regards different muscles at comparable levels and in individual muscles at different levels. It was found that smooth muscle fibers were present in forty-eight (87.3 per cent) of the specimens that were examined microscopically. No smooth muscle was found in seven (12.7 per cent) of the cases.

The foregoing data express in a quantitative manner a conclusion that had been gained from simple observation of all the histologic preparations, namely, that when the structure is attached to the second, third and fourth, or the third and fourth parts of the duodenum, it is largely muscular. On the other hand, cases having most of their attachment to the duodenojejunal flexure show a preponderance of connective tissue and a paucity of smooth muscle.

From Table II it can be seen that the suspensory muscle becomes progressively less muscular as sections are taken farther away from its duodenal attachment and closer to its diaphragmatic attachment. At the same time the connective tissue

TABLE II

Speci-men No.	Duodenal Attach-ment	Distance of Section from Duodenum (mm.)	X-Section Area in Sq. mm.	
			Smooth Muscle	Connec-tive Tissue
42	4 Flexure	21	14.68	4.89
42	4 Flexure	43	9.05	6.08
42	4 Flexure	62	1.43	12.08
28	2, 3, 4	25	17.45	3.95
28	2, 3, 4	53	7.13	6.15
5	Flexure	16	4.21	9.53
5	Flexure	46	0.61	6.55
19	3, 4	24	13.88	3.79
25	3, 4	24	9.53	2.87
37	2, 3	21	12.01	4.25

component increases in amount. Ultimately the latter blends with the fibrous tissue of the right crus of the diaphragm.

There is some considerable variation in the total cross sectional area of different specimens. Thus, sections taken from comparable levels have been found to vary from 21.40 sq. mm. in the case of specimen No. 28, to 12.40 sq. mm. in specimen No. 25. Qualitative examination of all specimens leads one to expect that had it been practical to make planimeter measurements of all cases this range of variation would be found to be greater than even the foregoing data show.

Planimeter measurements of the cross sectional area of a part of the circumference of the duodenum indicate that the total cross sectional area of smooth muscle in the wall of the duodenum at sites of attachment would range from 140 to 180 sq. mm. From the foregoing data (Table II) it is evident that in some cases the suspensory muscle would be capable of de-

FIG. 7. Photomicrograph showing attachment of the suspensory muscle to the duodenum. A, fibers derived from the longitudinal layer of the muscularis externa; B, fibers derived from the circular layer; C, muscularis externa of the duodenum; specimen No. 46; Van Gieson's stain; × 100.

veloping tension approximately one-tenth that of the duodenal musculature.

In some cases the muscle was sectioned parallel to the course of the fibers. Some specimens with relatively few muscle bundles permitted measurement of the length of the individual fibers. They were found to range in length from 92 to 242 micra.

The smooth muscle bundles are derived from both longitudinal and circular layers of the duodenum. Study of transverse sections of the duodenum at the site of attachment shows that the circular coat contributes more fibers to the suspensory muscle than does the longitudinal layer. (Fig. 7.)

The connective tissue component was invariably loosely arranged except in a few instances at the diaphragmatic end. The compact collagenous bundles seen in these cases are probably due to some of the crus being inadvertently excised with the muscle. Considering individual types of connective tissue, collagenous fibers were found to predominate. A few elastic fibers were found in the sections stained according to the method of MacCallum. A small

amount of adipose tissue was associated with the vessels supplying the muscle.

BLOOD AND NERVE SUPPLY

The blood vessels are derived from the inferior pancreaticoduodenal vessels as the latter lie in the interval between the muscularis externa and submucosa of the duodenum near the attachment of the muscle.

Small bundles of myelinated nerve fibers have been found in many specimens. Probably they are preganglionic vagus fibers. One would infer from the relation of the suspensory muscle to the gut musculature that the innervation would be comparable.

COMMENT

It is frequently stated[2] that the suspensory muscle is present and well developed in childhood and early adulthood, after which time the structure suffers atrophic changes with the result that its identity is lost in the loose connective tissue of the region.

We were unable to corroborate such a view. In the gross study, 89 per cent of the cases showed the presence of a definite anatomic structure and 87.3 per cent of these cases that were examined microscopically showed muscular tissues present. None of the specimens studied was under thirty-eight years of age while most of them were above fifty years of age.

In a roentgenographic study of 450 hospital patients Friedman[3] has shown that with advancing age the third part and duodenojejunal flexure remain relatively fixed, whereas the first part becomes progressively lower, and the second part becomes shorter and shifts toward the right. These observations are readily understood in view of our finding the suspensory muscle present in such a large percentage of the cases. The presence of a definite structure attached in whole or in part to the third and fourth parts of the duodenum and its flexure with the jejunum fits well with Friedman's observation of the constancy

of position of those parts over a wide age range.

Because of the nature of our material we have been unable to make a detailed correlation of the degree of development of the suspensory muscle with age. However, the considerable variation in muscularity seen in specimens of a restricted age range suggests that age is not a prime factor in the amount of development shown by the structure.

In view of our findings regarding the attachments of the muscle to the duodenum, some deductions regarding the functional attributes of the structure may be made. When it is attached to the second, third or fourth parts separately or in combination the angle between the duodenum and jejunum will be increased as the muscle contracts. In these studies we have consistently observed that the best muscularized specimens are attached to these parts. Planimeter measurements of the cross sectional area of a part of the circumference of the duodenum permitted an estimate of the total cross sectional area of the muscularis of the duodenum within the range of 140 to 180 sq. mm. Since muscle strength is a function of its cross sectional area, data in Table II show that in some cases the suspensory muscle would be capable of developing tension approximately one-tenth that of the duodenal musculature. There is thus the probability that the suspensory muscle is capable of decreasing the acuteness of the duodenojejunal flexure.

In the event the structure is attached principally to the flexure, it is evident that shortening would decrease the angle and contribute to obstruction. In our cases, however, there was so little muscle in specimens with this attachment, it is doubtful that obstruction could be contributed to in this manner. On the other hand, we have noted that when the muscle is attached to the flexure alone (8.8 per cent of the cases), it is shorter than in cases with other attachments. Probably not all of this is associated with duodenal topography. If this interpretation is correct, the

suspensory muscle in such instances would contribute to obstruction by kinking the flexure. (Fig. 5.) Indeed, Crosthwait[5] reports success in relieving duodenal obstruction by means of a procedure which includes doing a plastic operation on the suspensory muscle so as to increase its length.

The authors wish to thank Dr. P. A. Wheeler, Department of Pathology, Baylor University College of Medicine, for helpful suggestions regarding histologic technic. For skillful preparation of the material for histologic study we are greatly indebted to Miss Virginia Woolridge, technician in the Department of Anatomy. We also wish to thank Mrs. Ella May Shackelford Breckenridge of the Department of Visual

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ALTHOUGH primary hemangioma of a muscle is very rare, one occasionally encounters it in a skeletal muscle. There is a localized tumor having a rubbery feeling that is painful and which usually is intensified by movement of the muscle involved. There is also marked local tenderness and often a sensation of pulsations as well. The growth usually involves one of the muscles in a lower extremity. This condition undoubtedly is congenital but may be greatly aggravated by local trauma. Rhabdomyoma, hydatid cyst, fibroma or neurofibroma, fibrosarcoma, hematoma, myoblastoma or lipoma are a few of the other leading primary growths found in muscles. Primary hemangioma can be differentiated from the aforementioned by x-rays since 50 per cent of the patients show phleboliths, and by exploratory needle-puncture of the swelling in which practically 100 per cent of the patients demonstrate the presence of blood. (*Richard A. Leonardo, M.D.*)

CHOLECYSTOSTOMY*

A STUDY OF PATIENTS TEN TO SIXTEEN YEARS LATER

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IT is generally agreed that cholecystectomy is the operation of choice for cholecystitis with cholelithiasis. Yet cholecystectomy may be unnecessarily hazardous if the general condition of the patient is critical or if inflammation in and about the gallbladder makes accurate identification of the structures at the cystic-common duct junction impossible. The increasing number of traumatic strictures of the common duct indicate that too many cholecystectomies are being performed without good visualization of the cystic and common ducts. Where such visualization is impossible, good surgical judgment dictates cholecystostomy. Because of the advancing span of life severe degenerative lesions will more frequently complicate biliary tract disease. In such instances extensive operations for acute cholecystitis may be unnecessarily hazardous. Here, also, cholecystostomy has a place.

Some surgeons report a higher operative mortality in cholecystostomy than in cholecystectomy. Such comparisons are misleading because cholecystostomy has generally been used in the patient who is a poor risk. In comparable patients it is only reasonable to believe that cholecystectomy, which requires general or spinal anesthesia, better exposure, more extensive dissection and longer operating time, will result in a higher operative mortality than cholecystostomy, an operation which can be performed if necessary under local anesthesia. The greater immediate risk of cholecystectomy must be carefully weighed against the smaller chance of cure and the need of secondary operations when cholecystostomy is used.

The extent to which removal of the gallbladder increases the operative risk depends on the patient's condition, the skill of the surgeon and the operating facilities—variables difficult to measure. Although the immediate risks of cholecystostomy are smaller, the danger of incomplete cure is real. If a surgeon knew exactly what to expect from drainage of a diseased gallbladder, he could better gauge the need of risking cholecystectomy in the individual patient.

There are many reports of "end-results" in patients who have had cholecystostomies, but it seems to us that either too few patients were followed or that the follow-up period was too short for proper evaluation.

Cholecystostomies are being performed with less and less frequency on the Surgical Service of the Hospital of the University of Pennsylvania. Only when the patient is in extremely poor condition or when identification of the ducts is impossible is cholecystectomy abandoned, and subsequent cholecystectomy is always advised if the patient's general condition is satisfactory. Cholecystostomy is almost never done for chronic cholecystitis. The change in policy has been a gradual development. During the period 1931 through 1936 the indications for cholecystostomy were broader than at present, and most patients operated upon for acute cholecystitis and some patients with chronic cholecystitis were treated by cholecystostomy.

In an attempt to ascertain the long term morbidity following cholecystostomy, an analysis was made of all patients from the surgical wards of the Hospital of the University of Pennsylvania on whom this operation was performed during the six

years between January 1, 1931, and January 1, 1937. One hundred six patients clearly had disease of the gallbladder and comprise the group for study. Of these, five patients died in the hospital, giving an operative mortality of 4.7 per cent. Of the

TABLE I

AGE AT TIME OF CHOLECYSTOSTOMY
EIGHTY-FOUR PATIENTS

Decade*	No.	Per cent
10–19	0	0
20–29	3	4
30–39	16	19
40–49	22	26
50–59	18	21
60–69	19	23
70–79	6	7

* Average age—forty-nine years

remaining 101 patients, it was possible through questionnaires, personal examinations and interviews with family physicians to obtain an accurate follow-up on eighty-four patients or 84 per cent. Patients were followed either until death or for periods varying from ten to sixteen years.

ANALYSIS OF DATA ON EIGHTY-FOUR PATIENTS WITH CHOLECYSTOSTOMY FOLLOWED UNTIL DEATH OR FOR MORE THAN TEN YEARS

Tables I and II give the age at operation and the sex incidence of the group. More than half the patients were over fifty years of age and less than a quarter were under forty years. The high average age—forty-nine years—is explained by the fact that even in this early period most of the younger patients requiring biliary tract surgery were treated with cholecystectomy. As would be anticipated, more than two-thirds of the group were females.

Table III gives the pathologic process encountered at operation. Sixty-five patients (77 per cent) had acute cholecystitis with cholelithiasis, nine with stones in the common duct. Eighteen patients (22 per cent) had chronic cholecystitis, eight with

stones in the common duct. The high incidence of patients with chronic cholecystitis reflects the broad indications for cholecystostomy at this hospital from 1931 to 1936. The remaining patient, who had carcinoma of the head of the pancreas involv-

TABLE II

SEX INCIDENCE OF EIGHTY-FOUR CHOLECYSTOSTOMY PATIENTS

Sex	No.	Per cent
Female	60	71
Male	24	29

ing the gallbladder, died of metastases three months after operation and is not considered in subsequent tables.

The long term results of cholecystostomy in the eighty-three patients are shown in Table IV. Satisfactory results were ob-

TABLE III

PATHOLOGIC PROCESSES FOUND AT OPERATION ON EIGHTY-FOUR CHOLECYSTOSTOMY PATIENTS

Pathologic Process	No.	Per cent
Acute cholecystitis with cholelithiasis	56	66.6
Acute cholecystitis with cholelithiasis and choledocholithiasis	9	10.7
Chronic cholecystitis with cholelithiasis	10	12.0
Chronic cholecystitis with cholelithiasis and choledocholithiasis	8	9.5
Carcinoma of the head of pancreas involving gallbladder with cholelithiasis	1	1.2

tained in only 67 per cent. Thirty-nine patients had complete relief from the symptoms of gallbladder disease for periods ranging from ten to sixteen years or an average of thirteen years. Seventeen patients died of causes not related to biliary tract disease on an average of five years after operation. As far as could be determined from interviews with these patients' families and physicians, they were free of all gallbladder symptoms subsequent to cholecystostomy. One-half of the deaths were due to cardiovascular disease and the rest to miscellaneous

causes. It seems reasonable to include these seventeen patients as satisfactory results from cholecystostomy.

The number of unsatisfactory results were high, namely, one-third of the total group. Five patients died of disease originating from cholecystitis and cholelithiasis. Symptoms persisted in the remaining twenty-two patients, almost all of whom were advised to return for cholecystectomy.

Seven have refused to return for operation and continue to report symptoms. Sixteen subsequently returned for cholecystectomy and were operated on without a death. It is interesting to note that all but two of the secondary operations for gallbladder removal were performed within the first year after cholecystostomy.

In Table V a detailed breakdown of long term results is given in the acute group and

TABLE IV
RESULTS OF CHOLECYSTOSTOMY IN EIGHTY-THREE PATIENTS WITH CHOLECYSTITIS AND CHOLELITHIASIS FOLLOWED UNTIL DEATH OR FOR MORE THAN TEN YEARS*

Results	No. of Patients	Per cent	Period of Time
Satisfactory.........................	56	67	
Symptoms completely relieved.........	39	47	Average follow-up 12.8 years (minimum 10 years)
Death from unrelated cause............	17	20	Average of 5.4 years after operation
Unsatisfactory.......................	27	33	
Symptoms persisted..................	6	7	Average follow-up 13 years
Symptoms persisted requiring secondary cholecystectomy.....................	16	20	Average of 1.1 years after operation
Death from related cause.............	5	6	Average of 4 years after operation

* Including seventeen patients with combined choledocostomy and cholecystostomy

TABLE V
RESULTS OF CHOLECYSTOSTOMY IN SIXTY-FIVE PATIENTS* WITH ACUTE AND EIGHTEEN PATIENTS† WITH CHRONIC CHOLECYSTITIS AND CHOLELITHIASIS

Results	Acute			Chronic		
	No.	Per cent	Period of Time	No.	Per cent	Period of Time
Satisfactory...........................	43	66	....	13	72	
Symptoms completely relieved.........	32	49	Average 13 years	7	39	Average 12.5 years
Death from unrelated cause...........	11‡	17	Average 5.8 years	6‖	33	Average 5 years
Unsatisfactory........................	22	34	....	5	28	
Symptoms persisted..................	5	8	Average 13 years	1	6	13 years
Symptoms persisted requiring secondary cholecystectomy..................	15	23	Average 1.1 years	1	6	6 months
Death from related causes.............	2§	3	....	3¶	16	

* Including nine patients with combined choledocostomy and cholecystostomy
† Including eight patients with combined choledocostomy and cholecystostomy
‡ Heart failure, five; cerebral accident, three; tuberculosis, one; kidney disease, one; carcinoma colon, one
§ (1) Cholangitis two years after operation; (2) recurrent attacks acute cholecystitis, two subsequent cholecystostomies, the last fatal
‖ Heart failure, two; carcinoma stomach, one; carcinoma esophagus, one; cerebral accident, one; fracture hip, one
¶ All from recurrent cholangitis, occurring four, five and eight years, respectively, after cholecystostomy

in the chronic group. The percentage of satisfactory results was not significantly different for the two groups. It should also be noted that both Table IV and V include seventeen patients who had combined choledocostomy and cholecystostomy. Because the results of the combined operation were essentially the same as of cholecystostomy alone, the two groups have been consolidated in the tables. Fifteen of the seventeen who had the combined operation were jaundiced at the time of the original procedure and represent all the jaundiced patients in the entire series. The follow-up study of the fifteen jaundiced patients showed that nine were completely relieved of all symptoms; that four died of unrelated causes without further biliary tract symptoms; and that two died of causes related to biliary tract disease. Both deaths were due to recurrent cholangitis and occurred four and five years, respectively, after the original operation. Secondary cholecystectomy, which would have prevented reformation of gallstones if combined with thorough exploration of the common duct, might have prevented both deaths.

COMMENTS

Although the number of patients in this study is small, it is believed the long follow-up period allows certain definite conclusions. The authors made the study after noting that several patients who had cholecystostomies in the Hospital of the University of Pennsylvania refused to return for cholecystectomy because they were completely relieved of symptoms. An effort to determine the exact long-term results of cholecystostomy seemed indicated.

The percentage of satisfactory results, 67, is a generous estimate because it is probable that some of the patients who are tabulated as "unrelated deaths" were not free from gallbladder symptoms although we were unable to get a positive history from their families or physicians. Clearly the long-term results after cholecystostomy leave much to be desired.

The finding of greatest importance was that five patients subsequently died of disease originating in cholecystitis with cholelithiasis. Four had recurrent attacks of cholangitis which accounted for their deaths. The fifth continued to have attacks of acute cholecystitis which necessitated two subsequent cholecystostomies and died following the last operation. Cholecystostomy solved the immediate problem in these patients, but their deaths must be ascribed to the incompleteness of an operation which is not a curative procedure. Secondary cholecystectomy combined with choledochostomy where indicated would probably have prevented death in all. Physicians must be emphatic in urging subsequent removal of the gallbladder following cholecystostomy.

SUMMARY AND CONCLUSIONS

1. Cholecystostomy still has a place in the surgical treatment of acute cholecystitis when the junction of the cystic and common ducts cannot be adequately visualized or when the general condition of the patient is desperate.

2. Cholecystostomy must never be considered a complete, definitive, curative operation. A long-term follow-up study of eighty-four cholecystostomy patients showed unsatisfactory results in one-third. Five patients died because cholecystostomy was not followed by a more complete operation.

3. Unless clearly contraindicated by the general condition of the patient, every cholecystostomy should be followed by a secondary cholecystectomy irrespective of the length of time the patient remains symptom free.

FURTHER STUDIES IN ARTICULAR REPLACEMENT*

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ABOUT twelve years ago, in discussing some of the unsolved problems in fracture surgery with Clay Ray Murray, we included among these the internal fixation of fractures, the basic phenomena of bone healing, myositis ossificans, degenerative change following anatomical neck fractures of the humerus and subcapital fractures of the femur.

Some progress has been made since then in the partial solution of some of the problems. Recently, however, Paul C. Colonna[1] has again called attention to the present status of femoral neck fractures. Despite the improvement in modern technique of fixation, he states that "From the best statistics available today one may anticipate the development of late aseptic necrosis in approximately one-third of the cases united by solid bony union!" With degenerative arthritis as another complication, femoral neck fractures still remain what Kellogg Speed has called "The Unsolved Fracture."

About ten years ago the problem of articular replacement was attacked experimentally. As a result of observations on the effect of stress concentration and dispersion with internal fixation of fractures, the mechanical approach was avoided and a fresh idea was tried and eventually adopted. The reasoning was simple. If fixation of replacement elements to bone causes stress concentration and thus bone and other tissue death, diffuse the fixation of the stress-bearing elements. Allow the replacement elements to reach an equilibrium with the host tissue. The surgical attempt to carry out this idea was made in dogs and reported in the August 1946 Volume of "The Annals of Surgery" dedi-

cated to Allen O. Whipple.[2] One animal which had a follow-up of about five and a half years was included in the report. It is sufficient to say that except for certain technical difficulties, the dynamic relation of the donor element and the host tissue became stable and the idea of articular replacement without fastening at any specific points was feasible.

The purpose of this paper is to lay in your hand evidence that a new departure has been made in an attempt to answer the question implicit in "the unsolved fracture." Certainly the question of restitution of blood supply has been answered since by substitution regional blood supply is not needed. How far degenerative or hypertrophic arthritis of the acetabulum will complicate the picture, will depend on a long follow-up.

It so happens that parallel problems of restitution occur when the basic supportive substance of bone, which we call bone matrix, is destroyed by tumor, cystic disease or other processes or when the joint is encroached upon by various diseases.

In 1947 some bone matrix replacement studies[3] were reported. At this time we wish to report work done so far in the replacement of the femoral head and neck in six hips and one shoulder.

CASE REPORTS

Case i. No. 851272. A forty year old business woman was admitted to Presbyterian Hospital on December 11, 1946, for biopsy. She had had pain for about two years which had taken her to various doctors. The pain ultimately localized so that x-rays of the right hip taken on December 4th revealed a destructive

expansile lesion of the femoral head, neck and upper shaft. On December 12th a biopsy was performed on which a tissue diagnosis of chondrosarcoma of a well differentiated grade was made. Disarticulation was declined. The pain and disability continued and on January 30, 1947, following consultation, an arthrotomy was performed. A previously prepared element combining an acrylic polymer head, neck and shaft portion with three perforated intramedullary pins was used to replace the excised portion of the head, neck and shaft. She was placed in a plaster spica which was removed on April 13th. She began exercises with limited weight-bearing.

She continued to improve until at four months she was capable of full weight-bearing using a cane on the unoperated side to prevent faulty weight-bearing because of abduction weakness.

On April 1, 1948, approximately a year after she had started walking, she was re-admitted to the hospital because of a palpable mass in the anterolateral aspect of the mid-portion of the operative wound. The motion of the hip joint at this time was: limited flexion to 145 degrees, internal rotation 75 degrees, external rotation 90 degrees, abduction 45 degrees and adduction 25 degrees.

Re-exploration through the previous incision was done and a large tumor mass enveloping about one-third of the lucite portion of the replacement element was excised. Her wound healed per primum and sixteen days after operation the patient was up walking on crutches.

At operation the replacement element was quite mobile. The postoperative x-rays showed two of the fenestrated pins at their junction with the acrylic part to have fractured. Examination of the recurrent tumor revealed it to be again a well differentiated chondrosarcoma of limited malignancy.

One month after removal of the recurrence she was sent to a convalescent home able to crutch without weight bearing, and having no pain. (Fig. 1)

CASE II. No. 881007. A fifty year old farmer was admitted to the hospital on November 17, 1947, for articular replacement. He gave a history of gradual onset of stiffening and pain in the right hip which had been getting progressively worse for about ten years.

Stereoscopic x-rays showed essentially complete destruction of the joint with obliteration

of the joint space. The acetabular margin showed marked irregularity with cyst-like areas. The head of the femur was flattened and had an irregular density. The appearance was consistent with a severe degenerative osteoarthritis or a so-called malum coxae senilis. Other laboratory data were essentially negative. The right lower extremity showed a 3 cm. shortening with movement considerably limited. The flexion arc was from 90 to 165 degrees. Internal rotation was nil; external rotation was 30 degrees; abduction 15 degrees and adduction 5 degrees.

He was operated upon November 20th and the femoral head and neck were replaced with an articular element. He was placed in a plaster spica with the right leg slightly externally rotated with 25 degrees abduction and about 45 degrees flexion. He had a stormy course with several embolic showers requiring anticoagulant therapy for twenty-nine days. His plaster was removed thirty-four days after operation. Five days after plaster removal the passive movement in his hips was: flexion 125 degrees, external rotation 70 degrees, internal rotation 10 degrees, abduction 25 degrees and adduction 15 degrees. At this time he was able to bear full weight for a few steps without crutches but was not encouraged to do so. (Fig. 2)

At four months the patient was able to drive his car and walk although he still preferred crutch support because of some persistent pain in the region of the greater trochanter. At six months he was able to operate a planter and do moderate farm work. He gets about the house on a cane and elsewhere uses one crutch.

CASE III. No. 895878. A twenty-five year old army navigator lieutenant was admitted to the hospital on January 7, 1948. He gave a long history of difficulty involving both hips and spine. His earliest memorable difficulty was in July, 1942, at which time he had pain in the adductor muscles attributed to strain during a cross country run. He flew the Atlantic as a navigator until May, 1944. The patient was diagnosed as a case of Marie Strümpell's disease on June 1, 1944, and retired from active duty on December 11, 1944. His stiffness and pain continued to progress until February, 1946, from which time he was confined to bed.

At the time of admission examination revealed a pale young man confined to bed because of fusion of both hips, lumbar and dorsal spine. The cervical spine was fused with the
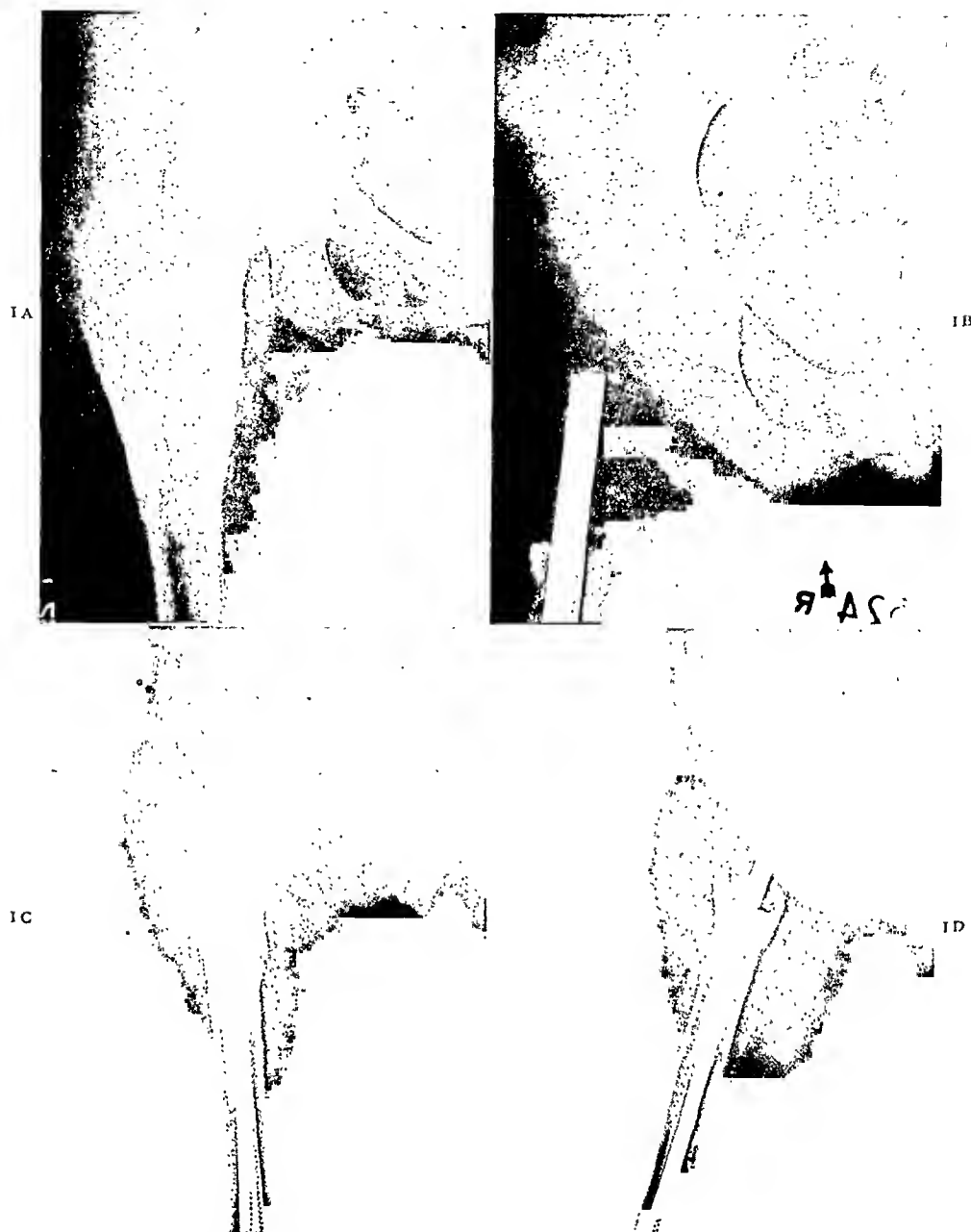
FIG. 1. Case No. 851272. A, preoperative film after biopsy; B, seven weeks postoperatively, patient bearing weight on one crutch; C, twenty-eight weeks postoperatively, patient bearing weight on one cane; D, one year and two months postoperatively, six weeks after excision of local recurrence.

head fixed in about 30 degree flexion. The temporomandibular joints retained about a 70 degree range of motion. The excursion of the thoracic cage was markedly limited and his vital capacity was 3.8 L. (original height 6 feet 1 inches, plus; usual weight 190 pounds; loss of 22 pounds). His organ systems were essentially negative except that at one test he had a congo red retention of 80 per cent and the blood

volume was about 62 per cent of normal; blood pressure was 145/90. Thighs and legs were tense, shiny and atrophic with some pitting edema. Knee motion was 150 to 120 degrees bilaterally and the ankle range was 120 to 100 degrees. Sedimentation rate was 58 mm., bleeding time four and one-half minutes; clotting time six minutes. He was thoroughly prepared and on January 13, 1948, a bilateral venous

2A

3A

3B

FIG. 3. Case No. 895878. A, preoperative film showing bilateral fusion; B, composite postoperative film, right hip five months and left hip two months after articular replacement.

2B
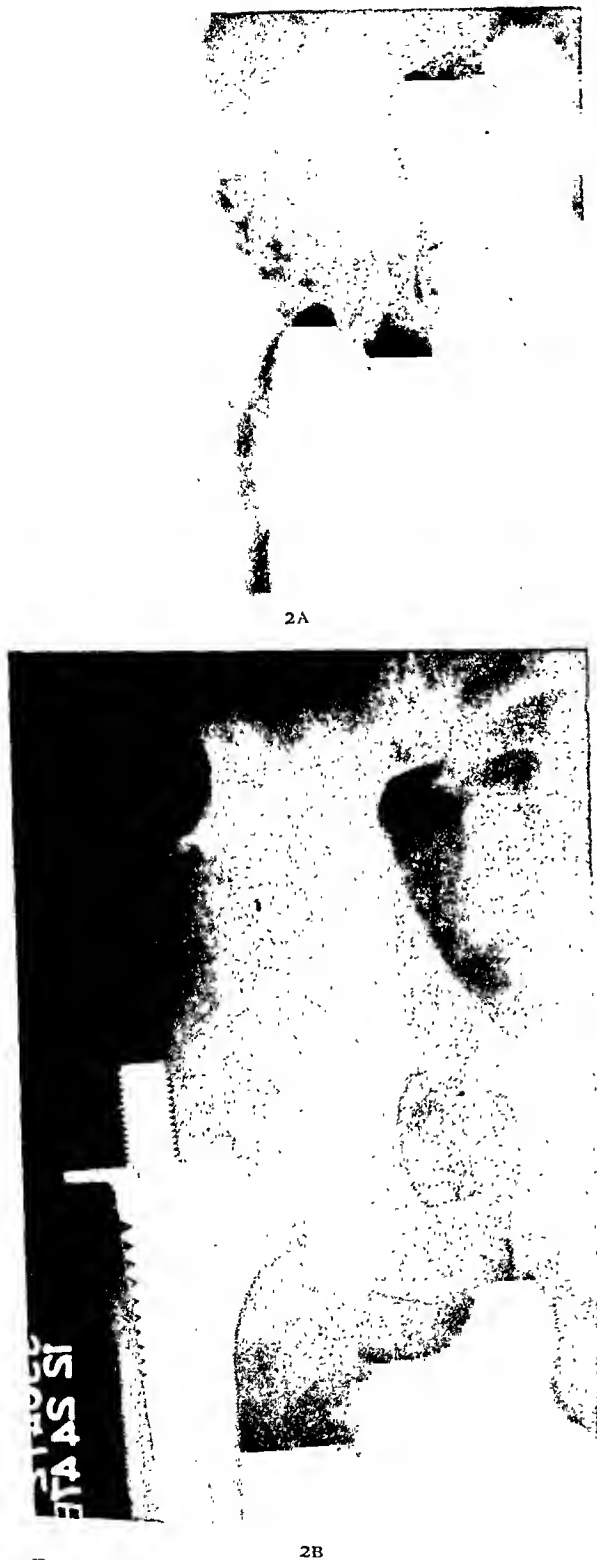
FIG. 2. Case No. 881007. A, preoperative film in severe degenerative malum coxae senilis; B, postoperative film.

ligation was done to reduce the likelihood of pulmonary accident.

On January 15th the right hip was operated

upon and the fused joint including all the diseased periarticular tissue was excised, and an articular replacement used to substitute for the excised femur. There was moderate vascularity and 2,500 cc. of whole blood was used. He tolerated the procedure fairly well and three days postoperatively was able to rotate his leg slightly. Rolled on his unoperated side, he had 10 degrees plus passive flexion and abduction of the hip joint without pain.

His postoperative improvement was not smooth but steady. On his eighteenth postoperative day he stood and began hesitant but real pendulum exercises, rediscovering muscles making adduction possible; also internal and external rotation and flexion. Except for some preliminary coaching he had not used these muscles in over two years. He showed steady improvement and at nine weeks was able to be up for an hour walking on crutches and having 30 degrees active motion in all planes. At this time he was capable of bearing full weight on

4A 4B

FIG. 4. Case No. 872470. A, preoperative film; B, postoperative film about six weeks after articular replacement.

the operated joint but was not encouraged to do so.

On April 12, 1948, just three months after the first operation, the left hip was done and an articular replacement used. On the seventh postoperative day he was gatched up in bed flexing his hips for the first time in well over two years. He was begun on muscle exercises. Twenty days after the second operation he was up for a short time on crutches. He was up and about progressively and five weeks after operation was able to spend about three hours out of bed, walking with crutches, sitting and exercising in the Hubbard tank. (Fig. 3)

CASE IV. No. 872470. A thirty-two year old ex-service mechanic who had had pain in his left hip for about twelve years was admitted to the hospital on March 9, 1948. His work-up was essentially negative and he was operated on March 15th with the application of an articular element. Postoperatively he was placed in Wilke boots in moderate internal rotation because the lateral rim of the acetabulum had been flattened and he tended to dislocate at the time of operation. When his wound was healed, he was placed in a plaster spica until five weeks postoperatively when he was started on exercises.

He was discharged forty-eight days following operation managing on crutches well but not bearing weight. At eight weeks postoperatively he was able to bear full weight but not advised to do so. At that time the active motion of his operated joint was: flexion 150 degrees, extension 180 degrees, internal rotation 20 degrees, external rotation 15 degrees, abduction 20 degrees and adduction 15 degrees. Passively, his hip flexion was to 90 degrees, extension to 190 degrees, external rotation 30 degrees, internal rotation 30 degrees, abduction 35 degrees and adduction 20 degrees. He was able to sit up in a chair without pain and to cross his legs. (Fig. 4)

CASE V. No. 904878. A twenty-one year old patient who worked in delicate machine assembly had shoulder stiffness and pain for about eleven years. At one time she was offered a "bone-scraping" operation which she refused. She went to another hospital where she was treated each Sunday for a whole year with x-ray, dosage unknown. She was seen by several other private doctors and ultimately went to a hospital where a biopsy was done and a diagnosis of chondroblastoma was made. She had the alternative of shortening and fusion or an articular replacement with relatively normal length. Her history and physical examination were essentially negative except for an old torticollis which had been cared for. The right shoulder and arm was considerably atrophic;

FIG. 5. Case No. 904878. A, preoperative film of ehondroblastoma (sarcomatous ehange at time of exeision; B, postoperative film six weeks after articular replaeement.

and although the elbow, hand and rotation movement of the forearm were essentially normal, the motions at the shoulder joint were about 10 per cent of normal and most of it was interscapulothoracic.

She was admitted to this hospital on April 5, 1948, for articular replacement. Previous to operation her laboratory findings were essentially normal. On April 8th the combined transacromial and Bankart type of approach was used for the section of the shoulder. The upper portion of the humerus was excised to about the level of the mid-portion of the insertion of the pectoralis major.

At operation the deltopectoral interval was completely obliterated with scar tissue and the substance of the deltoid obliterated and scar tissue had encroached everywhere except on a small section posteriorly. The shoulder cuff had disintegrated under deep therapy allowing the cuff muscles to retract. The only muscle tendon that could be identified was the teres major. A dense cord of fibrous tissue encroached upon the neurovascular bundle. The patient tolerated the procedure fairly well with the help of 1,000 cc. of whole blood.

In one week she was capable of adduction,

abduction and circumduction. In a month she could reach above the ear and to the midline posteriorly on the sacrum. The pain on movement was quite insignificant but her glenohumeral abduction remained only about ten per cent.

At seven weeks after operation she was doing her own ironing, ate her meals with the operated arm and could rotate her arm internally enough to button her dress posteriorly midline, lumbar 2. She could get both hands on the top of her head and brushed her hair and teeth with the operated arm. She still had some persistent bad weather ache but was improving and wanted to go back to work. (Fig. 5)

CASE VI. No. 876050. A sixty-four year old female was admitted to the hospital on February 21, 1948, for reconstruction of the left hip because of injury in April, 1946. At that time she sustained a subcapital fracture of the left femur which was treated at another hospital with Smith-Petersen nail insertion. She was admitted to this hospital on July 6, 1947, about a year and two months after her first operation for removal of the Smith-Petersen pin. She had pain on motion but managed to get about with crutches.
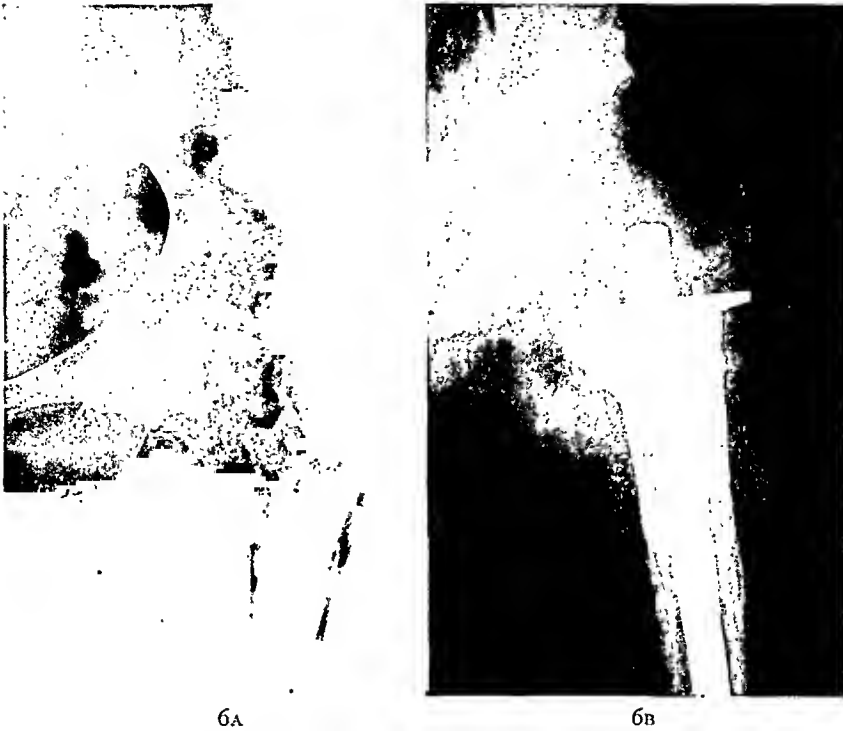
FIG. 6. Case No. 876050. A, preoperative film of hip two and a half years after fracture and pinning, showing aseptic necrosis of head and non-union of the neck of the femur; B, postoperative film six weeks after articular replacement with complete restitution of 2 inches loss of length.

Observation since that time revealed that not only was non-union present but that there was also about a 2 inch shortening and aseptic necrosis of the femoral head.

On February 24, 1948, the left femoral head and neck were excised and an articular replacement inserted. The immediate postoperative course was complicated by an acute condition of the gallbladder and a thrombophlebitis, left. The former was brought under control with penicillin therapy, the latter with anticoagulants.

The patient was up on crutches with pendulum exercises fifteen days postoperatively before the thrombophlebitis intervened forcing her back to bed. She was restored to ambulation one month and three days after operation and from then on her course continued to be uneventful. She was discharged on her thirty-eighth postoperative day. She had regained slightly more than her previous loss of length and was able to lift her leg off the bed for the first time in over two years. The motions at this time were: flexion 115 degrees, abduction 35 degrees, adduction 15 degrees, internal rotation 5 degrees and external rotation 35 degrees.

Two months and eleven days postoperatively the patient was walking rather well with crutches, using a cane in the house. She was able to put on her own shoes and stockings. Her only complaint was gluteal pain in the region of the posterior limit of the incision. (Fig. 6)

OPERATIVE PROCEDURE

The application of the replacement elements is not too difficult. Getting accurate measurements is one of the phases making ease of application possible. Familiarity with the hazards of intramedullary pin fixations and with the variability of the medullary canal facilitates the application of the articular element. The technics of the operator brought to its most basic components consists of the following:

Exposure. Utilize the anterior Smith-Petersen approach. Save, whenever possible, the rectus femoris and its attachment. Adequate detachment from both faces of the innominate bone contributes to ease of dislocation, excision of the femur and revision of the acetabulum.

Excision. Excise the capsule as completely as possible. This removes diseased and scar tissue allowing for greater operative flexibility. Estimate the amount of femur to be excised, allowing for restitution of length where possible. Excise the estimated segment with or without dislocation, depending upon limitation of movement, posterior scarring deformation and other factors. Save only the outer shell of the greater trochanter. Complete the excision of the posterior capsule. Essentially, this denervates the joint, reduces postoperative pain and muscle spasm. In well reconstructed cases active motion is possible on the first postoperative day.

Seating. Open the marrow canal and feel out its peculiarities with an intramedullary pin. Prepare the canal for the seating. Test the length of the open gap to be sure the fit for the head element is not too snug and that reduction is possible after the seating of the intramedullary portion. Seat the element with the patella straight up and the element externally rotated about 25 degrees. Reduce and test for motion, snugness and stability.

Closure. Settle the motor flanges into the trochanteric shell and suture into place pulling the shell anteriorly to snug up the gluteal aponeurosis. Where possible, utilize the reflected lateral portion of the rectus femoris and suture it to the anterior limit of the gluteal aponeurosis to stabilize against lateral slipping. Suture the deep covering of the tensor fascia femoris to the lateral limit of the rectus femoris. Close in layers. Where reconstruction is considered to be unstable, place in plaster. Otherwise, use only a posterior shell with cross bar to prevent rotation.

COMMENT

The acrylic polymer is suitable for the head element. Our own observations and those of Harmon[4] led us to the use of this material. It has characteristics which make it difficult to sterilize. However, when aged and free from catalyst contamination, it is relatively inert in tissue. Whether or not it can stand up against wear for ten years or longer remains to be seen.

It should be borne in mind that although only one case of post-fracture aseptic necrosis of the femoral head is cited in this series, the other hip cases reported were more complex and involved essentially the same process, namely, replacement of the diseased femoral head.

The remarkable freedom from pain and speed of rehabilitation depend upon the virtual denervation of the joint that goes with complete excision of the synovial membrane and capsule. This allows a hip in which the acetabulum has not been deformed and in which a good reconstruction is done to have pendulum exercises at three weeks. When the acetabulum is deformed and reconstruction is not strong, plaster immobilization for five weeks is indicated.

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SURGICAL ANALYSIS OF 124 CASES OF PROVEN ACUTE CHOLECYSTITIS

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THERE is no doubt in the minds of practicing physicians that an acute appendix should be removed immediately upon diagnosis. However, there is a tendency to apply another set of principles when the gallbladder is acutely involved; there exists the eternal hope that surgical intervention can be avoided. Those members of the profession who have been following the statistical studies during the past decade become cognizant of the fact that cholecystectomy is the proper treatment for acute cholecystitis; however, the question of when should the cholecystectomy be done has caused a lively debate.

Delayed surgical intervention often results in gangrene with perforation, leading to localized or generalized peritonitis. If the individual does recover from the acute attack, another is likely to follow and the ultimate result is cholecystectomy under less favorable conditions. Each attack with its toxic effects makes a lasting scar on the heart, kidneys and liver, augmenting the surgical risk. Therefore, the purpose of this survey is to examine the claim that the earlier surgical intervention is done in gallbladder disease the better are the results. We shall also try to determine how much time should be spent stabilizing the patient prior to operation. An endeavor shall be made to establish criteria for judging the readiness of an individual to undergo surgery when there is failure of immediate stabilization.

The cases in this study were taken from the records of Charity Hospital in New Orleans from the year 1937 to 1946. These records were taken from 320 charts signed: acute cholecystitis. In reviewing the records it often seemed that the diagnosis of acute cholecystitis was questionable for in several instances the individual had attacks of gallbladder colic which subsided in a few hours and which were relieved by medication. These attacks were unaccompanied by a temperature change, elevation of the leukocyte count, a palpable mass, prolonged pain or tenderness over the gallbladder area. After eliminating those cases in which diagnosis seemed doubtful there remained 209 cases of acute cholecystitis; 124 of these were demonstrated by surgery and one case by autopsy. However, this statistical study deals only with those proven surgically.

Cowley, in a twenty-two-year survey at Henry Ford Hospital, found twenty-five cases, of which twenty-four were proven by surgery and one by autopsy. Clagett stated that acute gallbladder accounted for 20 per cent of all biliary tract disease and Judd and Parker in 1924 noted that thirty-six or 4 per cent of 861 cases of cholecystic diseases were acute cholecystitis.

Of those treated surgically in the Charity Hospital group twenty-seven had been re-admitted to the hospital on one or more occasions. There were ten patients who had no previous attack of cholecystitis nor any history of digestive disturbance. In this group there was one death. There were sixty-seven whose histories bore witness of previous attacks; in this group there were seven deaths.

There were ninety-seven white patients of whom sixty-seven (69 per cent) were females and thirty (31 per cent) were males. Of the negroes twenty-seven (87 per cent) were females and four (13 per cent) were males. The totals were ninety females

(72 per cent) and thirty-four males (28 per cent). The ratio of 3:1 is contrary to the common belief that acute cholecystitis is equally prevalent in both sexes.

The age distribution can be obtained from the following table:

TABLE I

	Under 20	20–29	30–39	40–49	50–59	60–69	Over 70
Zinninger 81 cases	2	14	17	29	14	11	
Charity Hospital 124 cases	..	..	30	30	26	20	5
Eliason and Stevens 108 cases	23		48		37		
Saint 44 cases	1	0	5	10	18	18	

From Table 1 it is evident that the majority of cases, excluding those from Charity Hospital, were patients between the ages of thirty and fifty years. However, in the Charity Hospital survey the distribution is practically the same in the third, fourth and fifth decades and in the sixth it is relatively high. There were forty-three surgeons at Charity Hospital who participated in the procedures involved in these cases; only ten operated on five or more patients; three of these surgeons had no deaths occur and their operations took place within the first twelve hours after onset of symptoms.

It is interesting to notice the relationship between duration of present illness prior to hospitalization and the number of days spent in the hospital, also the relationship between duration of the present illness prior to the operation and mortality. In those patients whose present illness appeared only one to three days preoperatively there were seven deaths (12 per cent); in those in whom it appeared in four to seven days there were five deaths (17 per cent); in those in whom the illness appeared in two weeks there were three deaths (8 per cent), and in those in whom it appeared in three weeks, there was 1 death (21 per cent).

Among the fifty-four patients whose present illness was from one to three days

duration thirty-one were hospitalized two weeks, thirteen were hospitalized three weeks and ten were hospitalized four weeks.

Sixty patients were operated upon during the first three days of their illness, of whom seven died; twenty-eight were operated upon during the interval between the fourth and the seventh day, of whom five died. Of those operated upon between the first and second weeks three died. Three were operated upon during the third week. During the first postoperative week twelve died; during the second postoperative week three died and one died in each of the three following weeks.

In fourteen cases acute appendicitis was thought to be the cause of the acute condition of the abdomen. All fourteen patients had acute cholecystitis and three had an associated acute appendicitis. These figures are not in keeping with Mentzer's report which concluded that acute gallbladder disease was associated with acute appendicitis in 60 per cent of his cases.

In making a survey of this nature one is often tempted to venture a theory of his own. While gathering these statistics, the question as to how acute cholecystitis developed was always in mind. In attempting to answer that question it seems that it is necessary for the cystic duct to be obstructed either by stones or an inflammatory process; second, bile must be in the gallbladder to produce irritation; third, the secretions of the mucous membrane must continue or increase so as to produce tension; fourth, the tension thus produced must cause obstruction to the gallbladder blood supply causing tissue damage; finally, organisms must find their way into the necrosed tissue or multiply in the lumen to produce empyema. This seems to be the sequence of events in the development of gallbladder disease.

It is extremely difficult to establish a diagnosis in acute gallbladder disease due to the lack of past history and because the symptoms and physical findings are

misleading and do not always seem refer-
rable to the gallbladder. The impulse
initiating in the gallbladder may be
referred to other organs.

In 60 per cent of the patients studied
nausea was followed immediately by vomit-
ing or as late as eighteen to twenty-four
hours after the original onset. These
patients were not able to retain any food;
indeed, vomiting occurred without food
intake.

Dyspnea due to diaphragmatic irritation
was found to occur in only four patients
whereas Bodenstat reported this complica-
tion in 50 per cent of his patients. Jaundice
occurred in twenty-nine patients but was
complained of by fifteen; of this group
stones were found in twenty-four of the
patients who underwent surgical inter-
vention. Death occurred in four individuals
who had jaundice, two had and two did
not have stones.

Obesity is said to be a frequent finding
in gallbladder disease; Mentzer reported
that seventy-seven of his patients weighed
over 210 pounds. However, in the present
series only six of the patients were described
in the histories as markedly obese.

The chief complaint in 84 per cent of
the patients was pain over the gallbladder
area. This pain was penetrating in type
and in 58 per cent of the cases it travelled
to the area beneath the right inferior
scapular angle. These patients became
progressively worse and could not obtain
relief from ¼ gr. morphine sulfate. It was
necessary to administer ½ to ¾ gr. to
give the desired relief.

Indigestion was a complaint in 75 per
cent of the cases. These individuals gave
present and paid histories of food in-
tolerance, either qualitative or quantita-
tive. Their difficulty was mostly expressed
as indigestion following ingestion of greasy
foods.

Diarrhea occurred in only 3 per cent
of the patients and only one gave a past
history of Amoeba histolytica.

Temperature elevation on admission to
the hospital was as follows (Table II):

TABLE II

Degrees of Fever	No. Patients
0	26
1	37
2	25
3	29
4	8
5	6

The total white count was less than
9,000 in twenty-one cases among which
were four cases of gangrene of the gall-
bladder. The highest count was 32,000;
this was found in a patient who had an
associated pneumonitis.

There were forty-three patients who had
had previous x-ray and in whom stones
were found upon operation. The roent-
genologist was able to make a proper
diagnosis in eighteen cases and unable to
do so in twenty-five cases. There were
twenty flat plates and twenty-three that
had visualization of the gallbladder. The
dye failed to visualize the gallbladder in
twenty-one cases; in two of the cases in
which the gallbladder was visualized the
diagnosis of stones was made but operation
proved that there were no stones.

There were nineteen patients who pre-
sented a definite mass. This mass was
palpable as early as three hours after onset
and in five instances the mass arose after
the patient had been admitted to the
hospital.

Saint believed that a palpable gall-
bladder was a certain sign that immediate
operation was advisable. The present
series verifies this belief since in all cases
in which a palpable mass was found on
admission to the hospital there was gan-
grene of the gallbladder; in those cases
in which the mass arose after admission
there was no gangrene but distention was
found in two instances, in one instance due
to increased mucous content and in the
other due to purulent secretions.

It is important to be able to distinguish
acute cholecystitis from biliary colic. This
differentiation is often difficult since both
may be accompanied by nausea, vomiting
and a mild degree of temperature elevation.
Pain in acute cholecystitis, however, is

usually more difficult to handle than in biliary colic. In fact, any pain in the gallbladder area that lasts over two hours which is not relieved by morphine sulfate and atropine suggests acute gallbladder disease. Acute cholecystitis is a progressive illness. After administration of narcotics a soreness remains over the gallbladder area. When there is a high white blood cell count, elevation of temperature and a palpable mass the diagnosis is obvious.

Acute cholecystitis often may be confused with coronary thrombosis, but gallbladder pain is more severe and lance-like whereas coronary pain may be described as pressing and choking. Pain in coronary disease is usually referred to the left arm, but in gallbladder disease the pain is referred to the area beneath the right scapula. Gallbladder pain is long-lasting while coronary pain is not. Electro-cardiograms are helpful at times in differentiating the two diseases. From the total study of 320 cases there were no instances in which a patient with coronary disease was operated upon for acute gallbladder disease.

Perforated and perforating peptic ulcers are also difficult to distinguish from acute cholecystitis. The complication of an ulcer rupturing and becoming fixed to the gallbladder occurred in one patient in this series. The gallbladder was edematous and showed signs of acute inflammation only because of the perforating ulcer in the duodenum. This individual was operated upon with a preoperative diagnosis of acute gallbladder disease. However, two patients who were diagnosed preoperatively as having ruptured peptic ulcer were diagnosed postoperatively as having acute cholecystitis.

There were several complications of acute cholecystitis which were met in the course of this study. Acute gallbladder with rising intraluminal tension results in either a spontaneous overcoming of the obstruction or rupture through the gangrenous area, commonly the fundus. The blood supply is likely to be cut off due to tissue necrosis and pressure exerted on the

vessels from both intracellular edema and increased luminal pressure. If perforation occurs, it may be into the viscera or the free peritoneal cavity or it may form a localized abscess. Perforation occurred in two patients in this series, both negro females; one, thirty-five years of age, developed a subdiaphragmatic abscess and died; the other, forty-two years old, had a localized abscess and survived after a stormy course.

There were five diabetics with acute gallbladder disease, two of whom died; they had been in good condition before surgery but exploration of the common duct was undertaken. It appears that cholecystostomy would have been preferential in these cases. Typhoid fever was a complicating factor in four patients, one of whom died.

That the correct surgical treatment for acute cholecystitis is cholecystectomy remains unchallenged since this procedure is curative. Cholecystostomy should be considered a palliative procedure pending cholecystectomy as soon as the patient's condition permits. At least six of the eighteen patients in this series who underwent cholecystostomy required cholecystectomy at a subsequent time. Cholecystostomies should not be done when a cholecystectomy is possible for a gallbladder that has a part of its wall fibrosed and thickened by scar tissue cannot ever resume normal function. Cholecystostomies are indicated when technical difficulties arise or when the patient is acutely ill and time becomes an important factor.

Whether preoperative preparation has taken a great number of patients from the dangerously ill group and enabled them to withstand curative surgery remains to be demonstrated. At least the information gleaned from this survey is as follows:

The following division of the patients under study into the number of hours in the hospital prior to operation affords some idea as to the necessity of preoperative preparation and the importance of immediate surgery.

There were fifty patients operated upon between the third and the twelfth hour after admission to the hospital. The group included seventeen males and thirty-three females. There were thirteen (26 per cent) cholecystostomies and thirty-seven (74 per cent) cholecystectomies. The duration of illness prior to admission was 4.5 days. The duration of hospitalization of those who survived the first twenty-four hours was twenty-seven days, excluding one who remained in the hospital sixteen months. In this group there were six deaths, two of which occurred in those having cholecystostomy and four in those having cholecystectomy. Four of the six deaths, however, occurred within three hours after operation. These individuals were deemed extremely ill and the surgeons believed that immediate intervention was necessary. Procrastinating with these acutely ill patients for administration of fluids, vitamins, amino acids, etc., could hardly have been lost time since their chances of surviving were already nil. It is understood, of course, that when an earnest attempt to restore the physical level does not improve the patient's condition surgery must be attempted.

There were twenty-three patients operated upon between the twelfth and seventy-second hour after admission. In this group there was a definite attempt at stabilization. There were five males and eighteen females. Cholecystostomy was done in two (8.6 per cent). The average duration before admission was four days, hospitalization was eighteen days. There were nine deaths (38 per cent) of which two occurred during cholecystostomy. In eleven of these patients the pathologic condition was irreversible and surgery became imperative; cholecystostomy was done in only two patients.

The two foregoing groups lend themselves well to contrast. The number of days ill prior to hospitalization was practically the same; the duration postoperatively was twenty-seven days in the group operated upon within twelve hours and eighteen days in the second group. The mortality rate was 12 per cent in the first group and 30 per cent in the second. The number of cholecystostomies was 26 per cent in the first and 8.6 per cent in the second. Thus, it seems that the delay in surgery in an attempt to stabilize the individual was erroneous or the choice of procedure was erroneous. As it was shown an attempt to improve the debilitation in eleven cases proved unsuccessful. This seems to indicate that immediate surgery is the best choice of treatment although it may be palliative. The postoperative status was considered poor in six of the first group (12 per cent) and in ten of the second group (43 per cent). In those operated upon after seventy-two hours the postoperative status was poor in five (15 per cent). In those patients in whom cholecystostomy was done the preoperative condition was considered poor in ten; in three of the patients cholecystectomy was technically impossible.

There were thirty-three patients operated upon later than seventy-two hours after admission. There were nine males and twenty-four females. These individuals were ill (on the average) nine days before admission. Three had cholecystostomy performed and twenty-four underwent cholecystectomy. There were three deaths (9 per cent). The cholecystostomies were done because of the mechanical and technical difficulties encountered. The duration of hospitalization in these patients was thirty-eight days. These patients were observed and treated on an average of eight days before surgery was contemplated. Two of the three deaths occurred in patients undergoing cholecystostomy. It seems that a great deal of time elapsed in the attempt to stabilize the patients while they were growing progressively worse.

The technical difficulties that arose in those cases which occurred seventy-two hours or more after hospital admission separated that group from the previous ones. The edematous tissue which lent

well toward finding clearage planes and helped control bleeding was no longer found in the latter group for the tissues had become matted together by fibrosis. The bleeding became more difficult to control.

There were twenty-one cholecystostomies in this series, five of whom died (23 per cent). This high mortality rate is out of proportion to the figures given by Sanders whose surgical mortality rate of 3.4 per cent in acute cholecystitis rose to 10 per cent in choledochotomy. Of the twenty-one operated upon in this group seven had a stormy convalescence; ten of the twenty-one had no stones in the duct. Death was due to pneumonia in two cases and to subdiaphragmatic abscess in one. The hospitalization was increased eighteen days on the general average. The five who died had stones in the common duct with associated jaundice. Mayo pointed out that when choledochotomies were done in patients with jaundice the mortality rate rose to 58 per cent. With a serious rise in the mortality rate, the surgeon should not open the common duct except if there is definite evidence of: (1) palpation of stones in the duct; (2) jaundice either at the time of surgery or in the past history; (3) dilation of the duct with a small gallbladder and thick bile.

CONCLUSION

It seems from this study that early palliative surgery yielded the lowest mortality rate. It was 12 per cent in those operated upon immediately after hospital admission and it rose to 30 per cent in those in whom surgery was delayed. Individuals that fail to respond to preoperative preparation within a few hours should undergo immediate surgery. The surgeons who operated upon their patients immediately had the lowest mortality rate. Those individuals whose illness prior to hospitalization was short but followed by a rapid crescendo had a higher mortality rate than those who followed a slower course. It appears that these individuals were better able to cope with their illness.

There must be some unknown factor to determine the type of pathologic condition in these acutely ill patients. It appears that for a great number of them immediate surgery is the choice of treatment; yet for another group of these individuals, procrastination with an attempt to restore the physiologic condition would enhance operative risk.

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PHEOCHROMOCYTOMA*

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PHEOCHROMOCYTOMA is a rare, benign tumor of the adrenal medulla. [It has been reported with increasing frequency during the past ten years. Frankel in 1886 reported an autopsy on an eighteen year old girl who had bilateral adrenal tumors associated with cardiac enlargement. Von Neusser in 1897 described this tumor in connection with hypertension. In 1922 Labbe, Tinel and Daumer first described the clinical syndrome caused by these growths. The first to make a clinical diagnosis and advise surgical removal of this tumor was Vaquez, Donzelot and Geraudel in 1926. Their patient refused surgery and autopsy findings substantiated their diagnosis. In 1927 Charles Mayo was the first to remove successfully an adrenal medullary tumor but at the time he did not appreciate the nature of the tumor. Pincoffs and Shipley[22] reported a case in 1929 in which they were the first to make a correct preoperative diagnosis and to remove the tumor successfully.

That these tumors are exceedingly rare is shown by the figures of Brunschwig and Humphreys[4] who collected 109 cases up to 1939 of which but eighteen came to surgery, the remainder being discovered at autopsy. Kirschbaum and Balkin,[14] at Cook County Hospital, reported three cases in 14,437 consecutive autopsies. Clagett[16] reported that up until 1944 only thirty-one tumors of the 120 cases reported had been surgically removed.

ANATOMY

The suprarenal gland is composed of a yellowish cortical tissue and brownish medullary tissue which are fused together. The cortical tissue is derived from the lining of the celomic cavity (mesoderm) while the medullary portion comes from the neuroectoderm. This primitive neuroectoderm gives rise to two varieties of sympathetic nerve cells: the neuroblast and the pheochromoblast.[16]

The neuroblasts play the chief role in the formation of neuroblastomas and sympathicoblastomas. The neuroblasts also are the precursors of the sympathetic ganglion cells which are involved in tumors known as ganglioneuromas. These tumors give off no endocrine secretion.

The pheochromoblast is the important cell in the pheochromoblastoma which is malignant and rare.[18] These cells during their development acquire cystoplasmic granules possessing an affinity for chromic salts. They are often referred to as chromaffin cells and occur in the suprarenal medulla, carotid body and organ of Zuckerkandl.[15] Tumors of this type produce endocrine symptoms. The terms chromaffinoma and pheochromocytoma are used to describe suprarenal tumors of this type. They produce symptoms of hyperadrenalism. The term paraganglioma is reserved for extra-adrenal chromaffinomas such as carotid body tumors and tumors of the organ of Zuckerkandl. They do not produce symptoms of hyperadrenalism.

Phenochromocytomas occur equally in both sexes. Nearly all age groups are represented in the reporting of these tumors, the youngest being fourteen years of age and the oldest seventy-one.[3] Tumors in the older age group have been found at autopsy while in the younger group the diagnosis has been made clinically. The tumors occur more often on the right side[19] than on the left. Pheochromocytomas are usu-

ally confined to one side although bilateral cases have been reported. They are said to be morphologically benign and physiologically malignant tumors.[1] However, eight cases of pheochromocytoma have been reported in the literature[20] as malignant. They vary from the size of a pea to the size of a grapefruit. Weight variations have been from a few Gm. to 2,000 Gm. The tumor is usually encapsulated and incorporated in the suprarenal gland although some have been detached from the suprarenal and lie some distance from it.[25] Tumors on the right side are in close relation to and often adherent to the vena cava.

These tumors secrete a pressor substance into the circulation which is thought to be adrenalin. Beer, King and Prinzmetal[2] have actually demonstrated this adrenalin-like substance in these tumors by perfusing a denervated rabbit's ear with blood plasma removed from a patient suffering from symptoms attributable to a pheochromocytoma. Normally adrenalin is found in the blood in the order of 1:100,000,000.[1] The normal adrenals contain 4.22 mg. of epinephrine. Kalk[1] has found 375 mg. to 500 mg. of epinephrine in a tumor of this type. The clinical syndrome which is produced by the outpouring of this epinephrine-like substance is often called the adrenal-sympathetic or adrenal-medullary syndrome.

This syndrome is characterized by attacks of paroxysmal hypertension. During these attacks, which are due to the outpouring of adrenalin into the circulation, the patients have symptoms of violent headache, often of the unilateral type, palpitation and tachycardia, flushing, cyanosis, circumoral pallor, sweating, weakness, blanching of the terminal digits,[13] nausea, vomiting and syncope. Hyperglycemia and glycosuria are often present. During an attack the blood pressure may reach levels of 300 mm. of mercury systolic and 150 mm. of mercury diastolic. The clinical picture is not unlike that of shock,[6] these symptoms being those of adrenalin shock.

The interval between attacks becomes progressively shorter. They vary from an occasional attack to attacks several times during an hour. Attacks last from a few minutes to several hours. Changes in posture, pregnancy or any pressure on the tumor often initiate an attack. Many of the attacks, particularly in elderly people, end fatally. As a sequelae of frequent and prolonged attacks the patient often has resulting cardiovascular renal changes which are permanent.[11]

DIAGNOSIS

The diagnosis of pheochromocytoma is often difficult. Symptoms of hypermetabolism simulating those of hyperthyroidism or diabetes mellitus[8,9] are often confusing. Diabetes mellitus has been found in 7.5 per cent of the cases reported. Coronary occlusion, histamic cephalgia, migraine and anxiety states are many times considered in the differential diagnosis. Once the diagnosis of pheochromocytoma is entertained, intravenous and retrograde pyelograms may be of aid in determining the size and site of the tumor. Perirenal insufflation of air may aid in outlining the tumor in the roentgenogram.[2] This procedure is not, however, without danger in these hyperkinetic individuals. Massage over the affected kidney often produces an attack. Kvale and Roth[17,24] have described a test which has proved very successful for inducing an attack—administration of .05 mg. of histamine intravenously. Adrenalin and histamine are antagonists[23] and for this reason, adrenalin is secreted by these tumors following administration of histamine.

Goldenberg, Snyder and Aranow,[10] have developed a technic in which an adrenolytic compound, benzodioxane, is given intravenously. Benzodioxane abolishes adrenalin and is reported to be extremely helpful in making the diagnosis of pheochromocytoma.

Oscillometric readings of the extremities and studies of peripheral blood flow, as well as biologic assay[7,21] of the adrenalin

content in the blood plasma, are all helpful in confirming the diagnosis.

TREATMENT

The treatment of pheochromocytoma, once the diagnosis is made, is surgical. The sooner the tumor can be removed the sooner stress and strain will be alleviated from the cardiovascular renal · system. These patients are extremely sensitive to any surgical procedure. It has been found that when a pheochromocytoma is being removed, manipulation of the tumor causes an outpouring of adrenalin with an alarming rise in blood pressure[4] and that when the tumor has been removed, there is a precipitous fall in blood pressure. Sodium nitrite has been used to combat the critical hypertension during surgery and intravenous adrenalin, blood transfusions, saline and cortical extract are used to support the circulation when the tumor has been removed. It is often necessary to carry out these measures for several hours. Inhalation anesthesia has been used most frequently; however, spinal anesthesia has also been used but is considered too dangerous by most surgeons.

Various incisions have been used. Young[26] has described a posterior approach to both adrenal glands. A posterolateral kidney incision with removal of the eleventh and twelfth ribs has provided excellent exposure for removal of these tumors. The transperitoneal route,[5,12] also has been used with much success.

The mortality rate in removal of pheochromocytomas has been appalling, ranging from 25 to 40 per cent in various series reported. To add further to the limited literature on this type of tumor a case is presented which was correctly diagnosed preoperatively.

CASE REPORT

F. B., a male aged forty-three, was first seen at the Interstate Clinic on April 26, 1944, complaining of palpitation and irregularity of the heart, persistent non-productive cough, headache and pallor. He stated that for the previous five months he had at times had a "thumping feeling" over the precordium which would be associated with perspiration and headache. His wife stated that accompanying these attacks he appeared "pale and tired." He had lost 6 pounds during the past few weeks, but this was attributed to hard work while performing his duties as a drayman. His physical examination at that time was essentially normal except that his pulse was timed at 108 per minute. The blood pressure was 112 systolic and 78 diastolic. The urine was normal except for 2 plus albumin and 4 plus sugar. Roentgenograms of the heart and lungs were interpreted as normal. X-rays of the skull showed a normal sella turcica. An electrocardiograph was said to be normal as was his blood Wassermann. During the next two days he was given two basal metabolic tests and these were found to be +24 per cent and +20 per cent, respectively.

On May 1, 1944, he was hospitalized because of his diabetes. His fasting blood sugar was 271 mg. per cent. The glucose tolerance test showed a diabetic curve. He was given insulin and the diabetes was quickly brought under control. It was noted that during his five-day stay in the hospital he became flushed and had headaches. These symptoms were attributed to administration of insulin. He was discharged on a 2,000 calory diet and was taking sixteen units of protamine zinc and twelve units of regular insulin. His weight was 149 pounds.

He then went to Seattle, Washington to work in a shipyard and was not seen until May 14, 1945. At this time he stated that he felt fine and had gained 23 pounds. He had had an occasional severe headache and attacks of weakness. and sweating which he also had attributed to insulin. Upon examination, it was found that he had 4 plus sugar and he was again hospitalized May 15, 1945. At this time his blood sugar was found to be 240 mg. per cent. After seven days he was discharged on a diet of 2,400 calories and fifteen protamine zinc and twenty-five units of regular insulin. He returned to the shipyards and worked a year, during which time he had several "insulin reactions." His blood pressure during this two-year period ranged from 110/70 to 130/80.

In June, 1946 he returned to Red Wing and accepted a position as a distributor of news-

papers. He continued to take insulin and began having more frequent insulin reactions. His job necessitated bending over counting newspapers and his wife stated that he often came home after work exhausted, flushed, sweating and complaining of his heart pounding. On two occasions he became unconscious and was relieved by intravenous administration of glucose. On January 21, 1947, his fasting blood sugar was found to be 247 mg. per cent. Physical examination showed his thyroid gland to be slightly enlarged; pulse 120; blood pressure, 140 systolic, 100 diastolic; basal metabolic rate, plus 13. It was also noted that his feet had a bluish discoloration when in dependency.

On February 24, 1947, one of us (R. V. S.), stimulated by reading an article on phcochromocytoma, hospitalized the patient for study. Laboratory findings at that time were as follows: Hemoglobin, 15.8 mg.; red blood count, 4,810,000; leukocytes, 9,350; differential blood count: neutrophiles, 73; small lymphocytes, 6; large lymphocytes, 12; large mononuclears, 5; transitionals, 3; basophiles, 1; blood sugar, 252 mg.; blood urea-nitrogen, 16.5 mg.; creatine, 1.6; cholesterol, 150 mg.; total proteins, 9.2; serum albumin, 6.6 Gm.; globulin, 1.85 mg.; urea clearance, 82.7 per cent; basal metabolic rate, plus 33 per cent. Intravenous pyelograms (Fig. 1) showed the right kidney to be in slight vertical position with the upper pale not made out. The diagnosis was "a possible tumor in the region of the right adrenal." Hourly blood pressure readings showed the systolic pressure to vary from 100 to 250 mm. mercury and the diastolic to vary from 60 to 180 mm. mercury. Massage over the right kidney area brought on a typical attack with extreme hypertension. Intravenous histamine (0.10 mg.) caused the blood pressure to go, in ninety seconds, from normal to 260/180. Amyl nitrite was used to relieve the symptoms. Diagnosis of a pheochromocytoma of the right adrenal was made and the patient was operated upon on March 27, 1947.

Under sodium pentothal and ethylene anesthesia the right kidney area was exposed through a posterior incision described by Young. A tumor the size of an orange was found above the upper pole of the right kidney. The tumor was readily dissected free from the surrounding structures except on the medial side where it was firmly adherent to the vena cava. This dissection was time-

FIG. 1. Intravenous pyelogram showing downward displacement of right kidney.

consuming and was accomplished with a moderate amount of blood loss. This was anticipated and saline and citrated whole blood were started in two separate veins before surgery. Following removal of the tumor, hemostasis was accomplished and the wound was closed in the usual manner with a Penrose drain. The patient's blood pressure was 144/110 prior to the anesthetic. During manipulation of the tumor the blood pressure reached 210/160. When the tumor was completely separated from all of its attachments, the blood pressure (Fig. 2) dropped to 120/100. Adrenalin was administered intravenously. During the closing of the incision the blood pressure varied from 130/104 to 90/60. When the patient was returned to his room, his blood pressure was 140/90. For the next two and one-half hours almost continuous recordings of the blood pressure varied from "unable to record" to 174/140. In all, 7 cc. of adrenalin were given intravenously; 1,000 cc. of citrated blood and 500 cc. of saline and cortical extract were given. Two and one-half hours after completion of surgery the patient had a rather sudden collapse and died. There was no appreciable bleeding from the incision. An autopsy was refused.

Pathologic report was as follows: Grossly, the specimen measured 6 by 5 by 5 cm. It
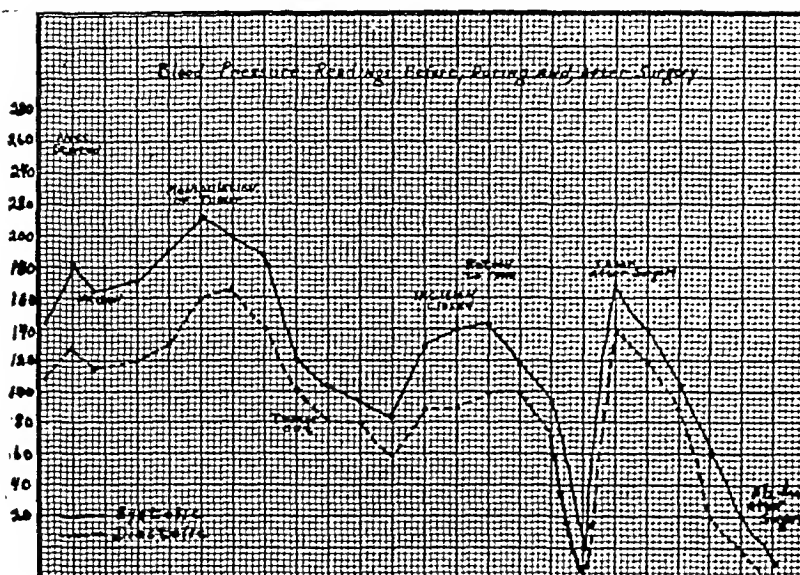
Fig. 2. Blood pressure readings showing extreme changes before, during and after surgery.

Fig. 3. Tumor after removal. After the blood supply was divided the tumor diminished in size.

Fig. 4. Microscopically the tumor showed well defined cells with small well stained nuclei.

appeared to be vascular. Attached to the medullary tumor there was a normal-appearing adrenal cortex. There was a rather definite capsule surrounding most of the tumor. (Fig. 3.)

Microscopically, sections of the adrenal tumor showed at one margin portions of the normal adrenal cortex. The tumor was composed of cells which were rather large and irregular in outline. The cell margins were well defined and in places the cells took on a rather pavement arrangement. Cytoplasm in the H and E stain was eosinophilic and the nuclei were fairly small and round. No mitotic figures were seen. The tumor was well defined and in places almost encapsulated. However,

the capsule of the tumor showed, in certain areas, infiltrating tumor cells. When the fresh tumor tissue was treated with potassium bichromate, the cells were found to contain brownish granulation. This, together with certain features of the histologic structures of the tumor, definitely fixed it as a tumor of medullary adrenal origin. Diagnosis: Pheochromocytoma. (Fig. 4.)

CONCLUSIONS

1. The literature on pheochromocytoma for the past ten years is reviewed.

2. A case of pheochromocytoma is reported in which a correct preoperative diagnosis was made. The tumor was re-

moved, with a fatal outcome two and one-half hours postoperatively.

3. It is noteworthy that this patient had concomitant diabetes mellitus and symptoms of hyperthyroidism.

4. It is believed that familiarity with the symptoms of this tumor will result in more cases being reported in the future.

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REVIEW OF MECKEL'S DIVERTICULUM

REPORT OF FOUR CASES

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DIVERTICULA may occur in any portion of the esophagogastrointestinal tract. They are of two types, congenital and acquired. The acquired variety is due to mechanical forces of pulsion or traction. Scar tissue adhesions to the wall of the alimentary tract may cause traction diverticula. Internal pressure from scybala or gas within the lumen are the factors principally involved in the etiology of pulsion diverticula. A weakened wall or atrophic musculature predisposes toward the formation of diverticula when distending forces act upon it. Acquired diverticula have no mesentery.

The congenital diverticula are of much more common occurrence than the acquired. They are due to a developmental anomaly. An example of this type of diverticula is the structure described by Meckel 135 years ago which bears the name Meckel's diverticulum. Priority of describing this structure should be credited to Lavater who wrote of it forty years earlier. It is essentially a diverticulum of the ileum, arising from the antimesenteric border of that organ at a variable distance from the cecum. It is a vestige of the ovovitellin duct of the embryo. Normally, this duct has disappeared within the first few weeks of intra-uterine life but, as shown by autopsy statistics, it persists in less than 2 per cent of individuals after birth.

Meckel's diverticulum may present a variety of forms. It may vary from a small, thimble-sized pouch to a tubular structure 10 cm. or more in length. There may or may not be a mesentery present. The sac usually has a blind end and lies free in the abdominal cavity. However, it may be attached at its distal end to any of the surrounding structures. The usual site of attachment is the inner aspect of the umbilicus. In cases of this type there has been a minimum of developmental regression. In a few instances the diverticulum does not have a blind end but forms a fecal fistula which discharges at the umbilicus. It may cause a prolapse of the umbilicus in the newborn or an omphalocele.

Littre's hernia is a name applied to abdominal hernias which contain diverticula. Meckel's diverticulum has been reported in umbilical, inguinal and femoral hernias. The most common site is in umbilical hernia. Left inguinal hernia is probably the next most frequent. The diverticulum may be incarcerated or strangulated.

Microscopically, the lumen is lined with mucosa identical with that of the ileum from which the diverticulum is derived. In a small percentage of cases ectopic gastric mucosa also occurs in the diverticulum. Rare cases have been encountered in which heterotopic rectal, colonic, jejunal and duodenal mucosa also have been seen.[12] In a still rarer group of cases, aberrant pancreatic tissue is found. Meckel's diverticulum is the most distal part of the alimentary tract in which pancreatic tissue has been found.

The pathologic condition resulting from Meckel's diverticulum is quite variable. A search of the literature has revealed reports on the following: (1) Pyogenic inflammations, regional ileitis, ulceration, gangrene, perforation, abscess and peritonitis have occurred. Typical gastric ulcers have developed in some of those patients with aberrant gastric mucosa. Perforations of gastric ulcer in Meckel's

diverticulum are on record. Cases of hemorrhage from gastric ulcer in Meckel's diverticulum are not very rare. This may occur in children. A case of sudden death was reported in 1943 in which a suspicion of poisoning arose but which, at autopsy,

opposite a Meckel's diverticulum containing gastric mucosa has been described.[10] (2) Foreign bodies may be present in the diverticulum in much the same way as in the appendix. Several cases of diverticular calculi are on record. They resemble

TABLE I

FINDINGS IN FOUR CASES OF MECKEL'S DIVERTICULUM

	Case I	Case II	Case III	Case IV
Date of operation	Nov. 27, 1946	May 21, 1947	June 24, 1947	Aug. 15, 1947
Color	White	White	White	White
Sex	Male	Male	Male	Female
Age	19	17	19	39
Pain	Two weeks; constant epigastrium	Three days; crampy, generalized	Twelve hours; epigastric and right lower quadrant	None
Nausea and vomiting	Both	Both	Both	None
Tenderness	Slight in right lower quadrant	Generalized	Marked, right lower quadrant	None
Muscle spasm	None	Slight	Positive, right lower quadrant	None
Temperature	97.6°F.	102.0°F.	96.8°F.	99.2°F.
Pulse	74	90	68	94
Respiration	20	22	20	20
Leukocytes	Normal	10,600	16,000	10,100
Preoperative diagnosis	Intestinal obstruction	Intestinal obstruction	Appendicitis, acute	Fibromyoma
X-Ray	Gastrointestinal series showed partial obstruction at mid-ileum; hiatus hernia	Flat plate: obstruction at ileojejunal junction	None	None
Pathologic findings	Long diverticulum attached to umbilicus by fibrous band; micro: ectopic gastric mucosa and pancreatic tissue with chronic inflammation; mesentery	Long diverticulum attached to umbilicus by fibrous band; abscess in distal end; micro: gangrene; ulcerated; edematous; markedly congested; mesentery; torsion of ileum or incomplete volvulus	Large bulbous diverticulum; (may be duplication of ileum); micro: ulcerated and inflammatory intestine; no mesentery	Small diverticulum; no mesentery; unattached; specimen not examined by laboratory
Complication	None	Right lung: pneumonia or infarction; pleural effusion	None	None
Days in hospital	52	55	16	9

proved to be a massive hemorrhage from an ulcer in Meckel's diverticulum. Gastric mucosa in Meckel's diverticulum functions as a "miniature stomach." Ulcers form in the intestinal mucosa due to the acid secretion of the misplaced gastric tissue. An ulcer of the ileum with perforation

fecaliths in the vermiform appendix. A case of a fishbone perforating a Meckel's diverticulum was reported in 1942[4] and another in 1943.[3] The writer reported a case of a fishbone perforating the base of the appendix in 1939.[6] Ascaris lumbricoides has been found in Meckel's diverticulum,
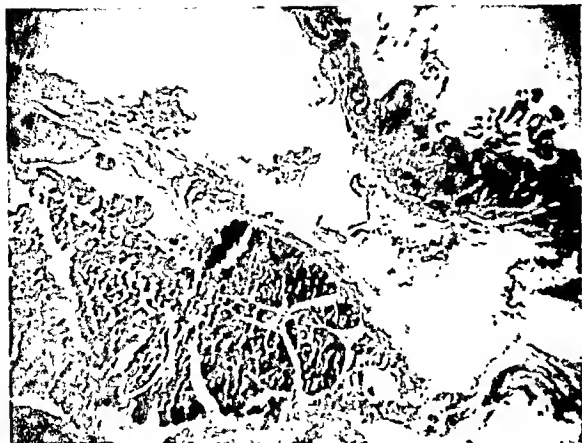
FIG. 1. Low power photograph of tissue sections from Case 1. In the upper right half of the picture the mucosa of the diverticulum can be seen. The lower left half of the photograph represents ectopic pancreatic tissue containing acini, ducts and islets.

causing inflammation and intestinal obstruction. Worms also have been found in the appendix. (3) Tumors of Meckel's diverticulum have been reported as a leiomyoma, polyp, neurinoma, adenoma and adenocarcinoma.

Diagnosis of Meckel's diverticulum is seldom made preoperatively. Conditions caused by Meckel's diverticulum and pathologic conditions due to the presence of a Meckel's diverticulum usually are misdiagnosed.[5] This is due in part to the infrequency with which Meckel's diverticulum is met and the fact that other more common lesions present similar symptoms. Inflammations of Meckel's diverticulum usually are diagnosed as appendicitis. The symptoms may be identical or there may be slightly atypical findings due to the position of the diverticulum in the abdomen.

Many patients with Meckel's diverticulum are operated upon with the diagnosis of intestinal obstruction. In such cases it is sufficient to diagnose the obstruction. The obstruction may be caused by numerous mechanisms involving the diverticulum. Cases of volvulus are probably the most common.

Intussusception at the level of the diverticulum is seen and intussusception due to invagination of the diverticulum has been reported. Cases are on record in which an obstruction was caused by Meckel's diverticulum tying a knot around the ileum. A polyp of the diverticulum has caused intussusception to occur in a case of Meckel's diverticulum. Adhesions of the diverticulum may cause internal hernia and obstruction.

An x-ray examination is of little value in the diagnosis of this condition. Golden[9] states that he has never visualized a Meckel's diverticulum in a roentgenogram, even in a case proved by operation. In eleven years at the Duke University Hospital twenty-one patients having Meckel's diverticulum had gastrointestinal x-ray studies, using barium sulfate, but in no case was there any x-ray evidence of the diverticulum.[12] In one of the cases presented herewith the diverticulum was not visualized in a gastrointestinal x-ray series. However, there have been several cases reported in which the diverticulum was demonstrated roentgenographically.[2,11]

About twenty new cases of Meckel's diverticulum are reported annually in medical literature. Although the autopsy incidence of Meckel's diverticulum is about 1.1 per cent, the surgical incidence may be somewhat higher inasmuch as some patients seen at surgery have the diverticulum removed and some patients are operated upon because of disease in or referrable to the diverticulum. Hence, there is greater likelihood of the condition being seen at operation than at autopsy.

Most cases of Meckel's diverticulum appear in children. All of the cases presented herein were in adults. (Table 1.)

SUMMARY OF CASES

Histologically, Case 1 in this series was the most interesting; the diverticulum contained heterotopic pancreatic tissue consisting of typical acini, islands and ducts. In sixty-one cases of Meckel's diverticulum collected for analysis by Howell no patient had ectopic pancreatic tissue.[12] In 1943 Mitchell and Angrist[8] collected twenty-three cases of Meckel's

diverticulum containing pancreatic tissue from the literature up to that time. In December, 1945 Troll added two more. The present case is the only one recorded since that time. Therefore, this is the twenty-sixth case of a Meckel's diverticulum containing pancreatic tissue reported in medical literature to date.

CASE I is also of clinical interest as the patient had an appendectomy performed eight years before for symptoms which persisted after operation. A month before his last hospital admission he was admitted to a hospital with similar symptoms but was discharged after having improved. This case well illustrates the error in not exploring the ileum after an apparently normal appendix has been removed[1,5] although the clinical picture was one of appendicitis. Many surgeons are reluctant to make a second incision in cases of this kind. This is very seldom necessary; the small bowel can be explored with ease through even a McBurney incision. About 1 meter of the terminal ileum should be examined if enough pathologic change is not found in the appendix to justify the diagnosis. If the ileum cannot be delivered, there is likely to be a diverticulum or some other pathologic entity which justifies an exploratory incision. (Fig. 1.)

Case II is interesting because the diverticulum contained an abscess in its distal portion. It also was causing a volvulus, resulting in partial obstruction.

Case III may not represent a true Meckel's diverticulum but rather a duplication of the ileum because of the large diameter of the diverticulum. However,

the distinction is too fine and, therefore, the case is included in this series.

Case IV presents no unusual phenomena. The diverticulum was small (about 5 cm. long), asymptomatic and was found on abdominal exploration during a hysterectomy.

No intestinal bleeding was encountered in these cases. This is to be expected in view of the findings in these diverticula. In all cases the diverticulum was excised and the ileum was closed by transverse suture.

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SURGICAL ASPECTS OF PERIPHERAL VASCULAR DISEASE*

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DISEASES of the peripheral arteries may be classified into three main types, degenerative organic, vasospastic organic and vasospastic functional.[20,22]

Organic arterial disease is exemplified by arteriosclerosis. This is by far the most frequent form of arterial disease and is rarely absent in advanced life. Pathologically, the disease is restricted largely to the intima of the large and middle-sized arteries but may encroach upon the media. The intima becomes thickened and degenerative changes are prominent. Calcification occurs in the necrotic areas with progressive obstruction of the lumen of the vessel. In the advanced stages thrombosis occurs and the lumen is filled with recent or partially organized thrombi.

This disease occurs in persons over fifty years of age. It affects both sexes approximately the same and usually affects the lower extremity to a greater degree. The lower legs and feet have a poorer arterial supply than the upper extremity and, therefore, are affected to a greater extent than the arms and hands. The outstanding symptom of arteriosclerotic peripheral vascular disease is intermittent claudication. Patients with this symptom develop severe cramps in the calf of the leg after walking one or two blocks and must sit down and rest until the arterial supply equals the tissue demand. After a period of rest they are able to walk again until the cramping pains recur. They also may complain of cold feet and occasional cyanotic discoloration. Examination usually reveals an absent pulse in the dorsalis pedis and posterior tibial arteries. When the extremity is placed in a dependent position, the color of the toes becomes blue and cyanotic. When the extremity is elevated, the color of the toes becomes white and cadaveric. Impending gangrene with definite discoloration of one or more toes together with early infection or cellulitis spreading up the dorsum of the foot is a common sight in the more advanced cases. Often these patients are not seen until definite gangrene of varying extent has occurred.

Vasospastic organic disease is exemplified by Buerger's disease. Pathologically, the earliest lesion is an acute inflammation of all layers of the artery and veins, with occlusion of the lumen by thrombi. With healing the thrombus becomes organized and the wall fibrotic. The artery, nerve and vein are involved in the inflammatory process and become densely adhered to one another. In addition to the obliterative endarteritis which is present there is marked vasospasm initiated by the inflamed vessels.

This disease occurs in patients under the age of forty. It is seen more often in males and usually involves the lower extremity. These patients also complain of claudication but in addition to intermittent claudication they have rest pain which awakens them at night and causes them to sit on the side of the bed and put their feet in a dependent position. They also may complain of bluish discoloration of the feet and state that their feet are cold and moist. On examination there is usually no pulse felt in the posterior tibial or dorsalis pedis vessels and in advanced stages one may see definite gangrene of the toes and foot.

Vasospastic functional disease is the type in which Raynaud's disease falls. In the early stages this is purely a functional vasospasm without primary organic disease of

the arteries. In the advanced stages of the disease there may be thickening of the arterioles of the peripheral vessels which have led some authors to believe that Raynaud's disease is primarily a vascular and not a sympathetic disorder.[14]

This condition usually occurs in young women between the ages of fifteen and thirty. The ratio of men to women is about 3:7. More often it involves the upper extremity. Patients with this condition complain of cold hands and fingers, increased sweating and pain in the tips of the fingers. The disease is characterized by a triphasic color change. The fingers first get white or blanched, following which they become cyanotic and blue which, in turn, gives way to a red, flushed appearance. The fingers become hot and tingling with relief from vasospasm and accompanying hyperemia. If this condition is allowed to progress, gangrene develops, usually of the distal end of the finger. Milder cases cause complaints of recurrent ulcers about the fingernails or pads of the fingertips. The condition is aggravated by any emotional upset or exposure to cold.

TREATMENT

Treatment of the arteriosclerotic type of arterial disease is aimed mainly at prophylaxis, that is, to prevent the occurrence of gangrene. Patients with this condition should be instructed carefully in the care of their feet. Extreme care should be used in trimming the toenails so as to avoid injury to the cuticles. Any infection or fungus disease should be cared for promptly. They are not to trim corns or open blisters but should consult their physician in regard to these affections. They are instructed to avoid getting the feet wet and cold for if frost bite occurs, these patients are very likely to develop gangrene. Heavy wool bed socks should be worn in the wintertime to prevent excessive coldness of the feet. An electric heating pad or hot water bottle may be placed on the abdomen at night to produce reflex vasodilation. Heat should not be applied directly to the extremity as it is

likely to burn the feet if one is not extremely careful. When there is impending gangrene, contrast baths are of value and can be done without elaborate equipment. These patients are instructed to immerse the feet in warm water for thirty seconds, following which they are placed in cold water for one minute. This is carried on for twenty minutes and by alternating dilatation and constriction a vascular exercise is accomplished which aids in the development of collateral circulation. The Pavex boot has been advocated for this condition; and if there is no infection present, it can be used with good results. These patients are encouraged to take about 1 ounce of alcohol two or three times a day as the vasodilatation which occurs is of definite help. The use of tobacco must be strictly forbidden. It has been shown definitely that nicotine causes vasoconstriction and a fall in the skin temperature especially in these patients who have an incompetent arterial supply. In selected cases lumbar sympathectomy is of definite value. These patients are first tested by doing a lumbar sympathetic block with novocain. If the temperature of the extremity increases and they are relieved of their claudication, sympathectomy is of value in preventing gangrene.

Once gangrene has occurred, treatment is aimed at preventing spread of the gangrene so that no more of the extremities than necessary will be lost. Penicillin or sulfa drugs should be given to prevent secondary infection of the gangrene which is usually a dry gangrene in the beginning. In addition the patient should use a 50 per cent alcohol solution which is applied to a bandage about the extremity and is kept moist continuously. Alcohol has the property of dehydrating the tissue and preventing wet gangrene; at the same time it is bactericidal and prevents further infection. Evaporation of the alcohol also cools the feet slightly and helps decrease the blood demand of the tissues. A lumbar sympathetic block should be done in all cases of gangrene to determine if any vasospastic element is present. If after a

block is done the extremity becomes warmer and the color improves, one must consider doing a sympathectomy as this often will make a difference in the level of amputation which may have to be done. Refrigeration is of definite value following a lumbar sympathetic block or sympathectomy. Interruption of the sympathetic impulses relieves any vasospasm that is present. It opens up collateral circulation and counteracts the vasospastic impulses created by applying cold to the extremity. By cooling the leg the metabolism of the tissue is decreased so that there is less demand for oxygen and the tissue needs can more nearly approach the available blood supply.[4,7] In addition the ice reduces pain, slows the absorption of toxins and discourages bacterial growth.[12,15] The leg first should be wrapped in cotton sheet wadding to protect the skin, following which four or five ice bags are placed about the extremity and a wool blanket wrapped about the legs covering the ice bags. This produces chilling but not freezing of the extremity and reduces the metabolism to a low ebb.

If amputation becomes necessary, one can use either low spinal or refrigeration anesthesia.[5] If refrigeration anesthesia is to be used, a tourniquet is placed just below the anticipated site of amputation and the extremity is packed in cracked ice. Thus the leg is frozen or almost frozen and the amputation can be done just above the site of the tourniquet without any further anesthetic. This is especially valuable in patients whose cardiac or respiratory status does not tolerate a general anesthetic very well. Low spinal anesthesia has proven to be very safe in those patients in whom the vascular system is not too seriously damaged. Spinal procaine anesthesia causes very little fall in blood pressure if confined to the lower neuron segments.

One must not be too conservative in doing amputations for arteriosclerotic gangrene. Occasionally, one may be able to amputate a toe if there is a good line of demarcation and there is no marked infec-tion, but once the process has spread beyond the webs of the toes, the next site of election should be the mid-tibial region. However, if no pulsations are palpable in the popliteal artery, the amputation must be done in the low thigh. We have found the Callander type of operation to be very satisfactory in this region.[8] Those patients in whom the femoral pulse is absent or markedly decreased would do better with an amputation in the middle or high thigh region.

Prophylactic treatment of the Buerger's type of disease is aimed at relief of vasospasm and the increase of blood supply to the affected extremity by opening up collaterals. Again alcohol is indicated in a moderate amount for its vasodilatory action and tobacco must be strictly forbidden in all forms.[13] Lumbar sympathectomy is of definite value to these patients for by relieving vasospasm and developing collaterals, the arterial supply usually will be sufficient to maintain the extremity. It is perfectly true that the sympathectomy had no effect on the progress of Buerger's disease. However, these cases usually run a definite course and eventually "burn out" so that by doing a sympathectomy, gangrene can either be prevented or limited to the distal portion of the extremity. Once definite gangrene has been established, a sympathectomy still should be done. Following sympathectomy the level of amputation can be more conservative and these patients are relieved of a great deal of their ischemic pain.

Treatment of vasospastic functional or Raynaud's type of disease is similar to that of Buerger's disease in that smoking should be avoided and alcohol should be used for vasodilatation. Patients with vasospastic functional disease are extremely sensitive to cold and it is often necessary that they leave a colder climate for one of more moderate temperature. They should be instructed to avoid chilling of the extremity. They should wear gloves in the wintertime and should not expose their hands to cold water or low temperature.

These patients are benefited to a great extent by cervicothoracic sympathectomy. There is still controversy among different authorities as to whether a preganglionic neurectomy or a sympathectic ganglionectomy should be done. Concensus of opinion seems to favor the preganglionic resecting of Smithwick.[10,16,17,24,25] Both methods have their points and, regardless of which type of operation is done, the patient will receive marked benefit by interruption of the sympathetic pathways. Of course, they must continue to avoid exposure to cold and tobacco.

VENOUS CLOTTING

Intravenous clotting has been divided by Ochsner and DeBakey[19,21] into two types, thrombophlebitis and phlebothrombosis. In thrombophlebitis the clot results from an inflammatory reaction in the vein and is firmly attached to the vein wall. Embolism does not occur unless a loosely attached red or coagulation thrombus forms proximal to the fixed white thrombus. On the other hand, in phlebothrombosis the intravenous clot is the red or coagulating variety unassociated with inflammation of the vein wall. In this instance the clot is loosely attached to the vein and may be detached easily to develop an embolus.

Clinically, thrombophlebitis presents the picture of chills, fever, tenderness over the involved vein with increased local heat and marked edema of the extremity. There are many etiologic factors in the production of thrombophlebitis.[9] Among the more important are trauma to the veins, stasis, infection and increased coagulation of the blood.[18] The most important treatment, therefore, is prophylactic. Trauma to the venous system should be specifically avoided. This is especially true in doing pelvic operations in which the operative field is closely adjacent to the larger pelvic veins. Gentleness in handling tissue and clean surgical dissection is important here as always. Following the operation stasis should be prevented. This can be done by

the use of bed exercise or by the bed bicycle as advocated by Gamble,[11] but the patient must be made to follow out the prescribed exercises. Compression bandages of the Ace No. 8 variety are of value in collapsing the superficial veins of the lower extremity and prevent slowing of the return blood flow. This is especially true in elderly patients and in any patient who has varicose veins. Bandages should be applied from the toes to the groin and kept in place until the patient becomes ambulatory. The use of early ambulation has been an important factor in reduction of postoperative thrombophlebitis in our experience. At the present time we get all patients, except those with peritonitis or distention, up on the first postoperative day and they are gotten up twice a day thereafter. By the third postoperative day they usually are able to walk to the bathroom. This in itself prevents stasis in the vessels, increases respiration and speeds up the circulation of the blood. Any infection present, especially that in the pelvis, should be combated with the usual surgical measures as infection and toxemia tend to cause intravascular clotting. Of much recent interest has been the use of anticoagulants, especially heparin and dicumarol. It is our policy to administer dicumarol to any patient who we fear might have thrombophlebitis. This includes elderly patients, any patients who have had extensive pelvic surgery or those in whom there has been marked intra-abdominal infection or trauma.[23] Any patient who gives a history of previously having had thrombophlebitis should receive dicumarol therapy to prevent recurrence. Dicumarol is started on the second postoperative day and usually is administered in 300 mg. doses the first day and 100 to 200 mg. doses each day thereafter in which the prothrombin time is thirty-five seconds or less.[6] The prothrombin level must be checked daily and the dosage governed accordingly. Since dicumarol does not act for about forty-eight hours after its administration, sometimes it is necessary to administer heparin until such time as the

dicumarol takes effect. This is given either intravenously or if Pitkin's media is used, it is given intramuscularly. Dosage must be carefully checked by the use of coagulation time.

Once thrombophlebitis has become established, active treatment consists of elevation of the involved extremity, the application of a heat tent and the wrapping of the leg in an elastic bandage to the groin. In addition to these measures dicumarol is started to prevent propagation of the clot which has formed and thus prevents spread or embolism. Lumbar sympathetic blocks should be given every twenty-four to forty-eight hours until there is definite subsidence of the condition. By the use of these measures the course of the disease can be shortened to about seven to ten days. Before institution of these measures thrombophlebitis usually ran a course from six weeks to many months and was followed by grave sequelae.

The clinical picture of phlebothrombosis is not nearly as dramatic as that of thrombophlebitis. The patient has no marked chills or discomfort and rarely complains of pain except for a slight discomfort or soreness in the calf of the leg. He may have an increased pulse out of proportion to his temperature and may be rather anxious about his condition or, as it has been described, "a sense of impending disaster." Examination usually will reveal a positive Homan's sign, that is, tenderness in the calf of the leg on dorsiflexion of the foot. Careful examination of the veins of the calf and the feet usually will elicit some tenderness over the course of the veins. Sometimes a diagnosis of phlebothrombosis is not made until the patient has had a fatal or near fatal pulmonary embolus. If pulmonary embolus has occurred, a meticulous examination must be made to determine from which extremity the clot arose and if it cannot be determined by clinical signs, one must consider ligating the superficial femoral vein of both legs.[1-3] Once the site of thrombosis has been determined, the veins must be ligated proximal

to the site of the clot to prevent further embolic phenomena. Anticoagulants also should be administered to prevent formation of clots in the veins of the other extremity or at other sites.

POSTPHLEBITIC EDEMA

Edema, which follows a phlebitis that has not been actively treated or has been very severe, is often a discouraging and debilitating condition. The patient gives a history of having had thrombophlebitis, usually following delivery or operation, and complains of persistent edema of the legs that may last for months or years following the initial onset of phlebitis. Some of the patients with this history are almost completely debilitated, are unable to stand or walk for any length of time because of the heaviness and aching sensation accompanying the marked edema of the extremities. The edema is due to persistent reflex arteriospasm resulting from the chronic inflammatory reaction which remains in the veins following phlebitis.

The treatment consists of urging patients to wear elastic hose to prevent the edema together with giving repeated lumbar sympathetic blocks to relieve arteriospasm and reduce the edema. Those patients who do not respond completely to repeated lumbar sympathetic blocks should have a permanent sympathectomy done. The improvement following sympathectomy is not dramatic, but persistent vasodilation over long periods of time will gradually decrease the amount of edema present and usually will allow these patients to return to their normal activities.

SUMMARY AND CONCLUSIONS

1. Diseases of the peripheral arteries have been discussed under the classification of (1) degenerative organic disease (arteriosclerosis); (2) vasospastic organic disease (Buerger's); and (3) vasospastic functional disease (Raynaud's).

2. Treatment of arteriosclerosis is aimed mainly toward the prevention of gangrene.

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Once gangrene has occurred, amputation is indicated but the levels of amputation may be modified by interruption of the sympathetic nerves. The value of refrigeration is discussed.

3. Buerger's disease is best treated by abstinence from tobacco, the moderate uses of alcohol and sympathectomy.

4. Raynaud's disease is generally conceded to be vasospastic in origin, based on a hypersensitive sympathetic reaction to tobacco, cold or emotional upset. Cervicothoracic preganglionic sympathectomy is the treatment of choice.

5. Venous clotting has been discussed under the heading of thrombophlebitis, phlebothrombosis and postphlebitic edema. Emphasis has been placed on prophylaxis.

6. Sympathetic blocks and anticoagulants are advocated for thrombophlebitis.

7. The dangers of embolism in phlebothrombosis have been stressed and the use of vein ligation together with anticoagulants has been discussed.

8. Postphlebitic edema is a debilitating disease. Sympathetic nerve interruption is of definite value in rehabilitation.

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GLYCERITE OF HYDROGEN PEROXIDE*

A COMPARISON OF ITS BACTERIOTOXIC EFFECT ON CLOSTRIDIA WITH THAT OF OTHER ANTISEPTICS

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WHEN it was found that relatively stable solutions of urea peroxide[3] and of hydrogen peroxide[6] in substantially anhydrous glycerol could be prepared, studies were made of its bacteriologic and toxicologic properties.

Comparisons of the peroxide solutions with mercurial solutions[4] and with iodine solutions[5] by a cylinder plate method have been reported. The physiologic properties of the peroxide-glycerol solution have been described.[1,2] The present paper records the results obtained in comparing the action of glycerite of hydrogen peroxide on Clostridium welchii and Clostridium tetani with that of thirty-two commercial antiseptic solutions.

Aqueous peroxide solutions have been used to a considerable extent and urea peroxide crystals to a lesser extent in the treatment of anaerobic infections. Many references in the literature[7,16] refer to lavage with peroxide solutions. Some workers have injected such solutions. The latter procedure is accompanied by considerable danger due to embolus[9] or gas formation in the tissues.[8] Peroxide solutions obviously should not be used in closed spaces. Meleney[11] recommends thorough exposure of the affected tissue to the active agent. This holds true for all topical applications, regardless of the type of medication. The poor results reported for some peroxide compositions[10] appear to be due, in part at least, to failure in following this recommendation. Another possible error is due to the fact that peroxide solutions in the usual concentrations are relatively slow in their bactericidal action and hence must be in contact continuously with the organisms.

Many of the commercial antiseptic solutions, such as some of the mercurial solutions, have a rapid bacteriotoxic and slower (frequently much slower than peroxide) bactericidal action.

As in the other comparison studies previously published, a cup plate technic[15] modified by the use of glass or porcelain cylinders was used. The method was described in the first paper of the series[4] and consisted essentially as follows: Difco dextrose agar, with and without 10 per cent added horse serum, was preinoculated with 0.2 ml. of a twenty-two to twenty-six-hour culture of the organism for each 25 ml. of melted agar. After the poured plate (100 mm. diameter) had hardened, slightly warmed cylinders, 8 mm. in outside diameter the rims of which had been paraffined, were placed on the agar. The solution to be tested was placed in the cylinders in 0.2 ml. amounts. The plates were immediately incubated anaerobically[13] for eighteen hours. Subcultures of approximately 3 mm. cross section were taken radially from the edge of the cup and placed in modified Brewer's thioglycollate medium and incubated at 37°C. for at least seven days.

After subculturing, the distance of the outer edge of the clear zone, if any, to the outer edge of the cup was measured to the nearest 0.5 mm. and recorded for each cylinder. At the same time the distance from the edge of the cylinder to the inner and outer edge of the indentation left by the removal of material for subculturing was measured and recorded. Because of space limitations the table shows only the average distal measurement of the subculture area closest to the cup that showed

growth in the subculture tube. This procedure obviously favors the antiseptic. At least three, and in some cases more, replicate tests were made. The values in the table have been rounded off to the nearest whole number since this is sufficient for comparative purposes. (Table 1.)

Although solutions of urea peroxide in glycerol are in general more stable than similar solutions in water, some lots of glycerol yield solutions that are less stable than others. Hydrogen peroxide solutions in glycerol are apparently of short life in the absence of stabilizing agents. It was

TABLE I

BACTERIOTOXIC ACTION OF ANTISEPTIC SOLUTIONS ON CLOSTRIDIUM WELCHII AND CLOSTRIDIUM TETANI IN THE PRESENCE AND ABSENCE OF 10 PER CENT HORSE SERUM

Solution*	Clostridium Welchii		Clostridium Tetani	
	Plain	10% Serum	Plain	10% Serum
Glycerite of hydrogen peroxide	18†	26	39	39
Glycerite of hydrogen peroxide (with urea)	20	20	33	34
Glycerite of hydrogen peroxide (with oxine)	25	15	41	28
Glycerite of hydrogen peroxide (with oxine and urea)	22	21	37	37
Tincture of hydrogen peroxide	21	26	35	35
Glycerol saturated with oxine	2	10	3	4
Mereresin, tincture 1:1000	9	7	15	11
Mercurochrome aqueous 2%	3	6	11	10
Mercurochrome, surgical 2%	5	3	19	12
Metaphen, tincture 1:200	10	8	16	13
Metaphen, aqueous 1:500	5	4	15	8
Merthiolate, tincture 1:1000	7	3	19	11
Merthiolate, aqueous 1:1000	3	4	13	10
Merthiolate, glycerite 1:1000	8	5	15	6
Merseptal, tincture 1:500	3	8	14	10
Merseptal, aqueous 1:1500	3	3	15	10
Merbromin, surgical 2%	5	9	23	13
Merbromin, aqueous 2%	3	5	14	9
Iodine, tincture USP 7%	26	19	42	39
Iodine, tincture mild 2%	13	8	31	21
Biodone (aqueous iodine) 2%	9	9	21	18
Iodine, aqueous N.F. 2%	6	4	17	14
Iodine, glycerite 2%	9	11	27	19
Zephiran, tincture 1:1000	2	2	8	3
Zephiran, aqueous 1:1000	2	2	6	5
Phemerol, tincture 1:500	3	3	6	3
Phemerol, aqueous 1:1000	2	3	5	3
Cepacol, tincture 1:4000	3	2	0	0
Ceepryn, tincture 1:500	0	0	0	0
Ceepryn, aqueous 1:1000	0	0	0	0
Acriflavine (1:1000)	3	3	5	7
S.T. 37 1:1000	8	3	8	4
Azochloramide (1:3300)	3	2	6	7
Tenicide	8	6	25	13
Auralgan	6	16	5	3
Otosmosan	3	4	4	4
Otomide	3	11	34	14
Lysol (1:64)	8	0	6	5

* The commercial antiseptics were used full strength except where the concentration is given in parentheses.
† Subculture zones were measured radially in mm. from the edge of the cylinder.

found that the addition of small amounts of oxine (8-hydroxyquinoline) resulted in greater stability with all lots of glycerol and permitted the use of concentrated hydrogen peroxide (90 per cent) in making stable solutions.

The solutions tested, with their concentrations, are shown in the table and will not be relisted here, except for the peroxide compositions and some lesser known solutions which are mixtures. The composition of the peroxide solutions was as follows:

Glycerite of hydrogen peroxide: hydrogen peroxide 1.5 per cent in glycerol
Glycerite of hydrogen peroxide with urea: urea peroxide 4 per cent in glycerol
Glycerite of hydrogen peroxide with oxine: hydrogen peroxide 1.5 per cent; oxine 0.1 per cent in glycerol
Glycerite of hydrogen peroxide with oxine and urea: urea peroxide 4 per cent: oxine 0.1 per cent in glycerol
Tincture of hydrogen peroxide: urea peroxide 4 per cent; oxine 0.1 per cent in alcohol 50 per cent; acetone 10 per cent; water 40 per cent

The compositions of the following are those shown on the respective labels.

Otomide: sulfanilamide 5 per cent; urea 10 per cent; chlorbutanol 3 per cent; glycerol
Auralgan: antipyrine 0.87 Gm.; benzocaine 0.23 Gm.; glycerol 0.463 fl. oz.
Otosmosan: urea 2.4 Gm.; sulfathiazole 2.02 Gm.; benzocaine 0.20 Gm.; glycerol 20.0 Gm.
Tenicide: alcohol 56 per cent; chloroform 8 per cent; iodine (total) 1.2 per cent; zinc sulfocarbolate, salicylic acid, formaldehyde, thymol and camphor

COMMENT

The control solutions, "tincture solvent" (50 per cent alcohol, 10 per cent acetone, 40 per cent water) glycerol and alcohol 70 per cent gave no zones under the experimental conditions.

With the exception of U.S.P. tincture of iodine which was essentially equal in potency, the glycerite of hydrogen peroxide compositions were far more effective in bactericidal action than any of the other thirty-two solutions. This is to be expected somewhat because of the oxidizing nature of the solutions and the anaerobic character of the organisms. That this activity was not due to the presence of free oxygen in the space above the plate is indicated by positive subcultures. If aerobic conditions were present due to free oxygen, it would be expected that no growth would appear. Some visible growth was apparent in all the plates.

The presence of serum appeared to have less effect on the bacteriotoxic activity of the majority of solutions than was the case with aerobic cultures.

The strain of Cl. tetani used proved to be more susceptible to all the antiseptics but more particularly to the peroxides than was Cl. welchii.

All the mercurial solutions showed effects of essentially the same order. The cationic solutions showed the usual low degree of activity. The point has been made[14] that tests using agar are not suitable for the evaluation of quaternary ammonium salts. Since both agar and tissue have an electric charge of the same sign it would seem that the use of agar would give a better indication of the activity of cationic substances on massive tissue areas than the use of methods which do not use material with a charge of the same sign as that of the tissue on which it is to be used. The formation of a surface film on skin[12] with viable organisms underneath would seem to bear this out.

Otomide containing a 5 per cent sulfanilamide showed a considerable zone with Cl. tetani, a much smaller one with Cl. welchii. The iodine solutions showed more activity with Cl. tetani than with Cl. welchii.

SUMMARY

In cylinder plate tests on Cl. welchii and Cl. tetani glycerite of hydrogen peroxide solutions showed much greater activity than did thirty-two other antiseptic solutions with the exception of U.S.P. tincture of iodine. Twelve mercurial solutions showed less activity than did the peroxide

solutions and were of about equal activity when compared with each other. Seven cationic solutions failed to demonstrate activity in several cases and were of slight effect in other cases. Otomide, a solution containing sulfanilamide, produced a zone of considerable size with Cl. tetani.

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SURGICAL MANAGEMENT OF THE MORIBUND BURN PATIENT

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EXTENSIVE burns are critical burns which are a threat to life. Anemia and hypoproteinemia make their appearance early due to the toxic changes and vast amounts of protein lost from the burned surfaces and kidneys. Progressive debility occurs in direct proportion to the extent of the exposed burned surfaces. The more extensive the burn, the more difficult the process of maintaining physiologic blood levels and the more debilitated the patient becomes. As skin grafting procedures are carried out diminishing the total exposed body surface, the toxic processes diminish. The erythrocytes are not destroyed so quickly and proteins are conserved.

Careful medical therapy is essential in attempting maintenance of normal physiochemical levels. Once they have been materially lowered it is extremely difficult to elevate them to approach the normal. In extensive burns medical therapy alone cannot maintain these levels. Spontaneous epithelialization or skin grafting must be in advance of the chemical processes which tend to emaciate the burn patient.

In a previous communication[2] it was pointed out that thin dermatome skin grafts would take well in moribund burn patients with the hemoglobin as low as 30 per cent and the plasma protein level as low as 5 in the presence of infection.

It is the purpose of this paper to discuss a rapid non-shocking technic of skin grafting which has been found to be successful in the treatment of moribund burn patients.

MANAGEMENT OF THE EXHUBERANT GRANULATIONS

Early operation is highly desirous when treating burn patients who require skin grafting. The time to graft is when the recipient area is free from débris and has assumed a clear, healthy appearance. This period is inconstant and varies with each individual case. Cope et al.[1] showed by a large series of cases that "the ideal treatment, that is excision of the full-thickness wound destruction within the first hours after injury with immediate closure of the wound by split thickness grafts" worked out extraordinarily well. If for any reason operation has been delayed, soft pliable granulations may be present which bleed freely with a minimum of manipulation. Occlusion dressings tend to keep them in check. If the dressing is dry, unnecessary large quantities of blood may be lost with each change of dressing. Moore et al.[7] found that "a loss of 75 to 150 cc. of whole blood was determined each time the dressings were changed and a loss up to 200 cc. with each grafting." A layer of petrolatum-impregnated gauze under the pressure bandage will minimize the blood loss with dressing changes.

It is universally accepted that for the best results in delayed skin grafting, the exhuberant granulations should be removed before applying the graft. This is a sound grafting principle. When exhuberant granulations are shaved or scraped down, marked capillary oozing occurs with the loss of 250 to 500 cc. of blood. In most grafting procedures this blood loss is well tolerated by the patient with little ill effect. In moribund burn patients any procedure which tends to cause an excessive blood loss is dangerous and best omitted. Besides the deleterious effect of further diminishing the blood stores, excessive bleeding prolongs the operation and enhances the shock and depressing action of the anesthetic.
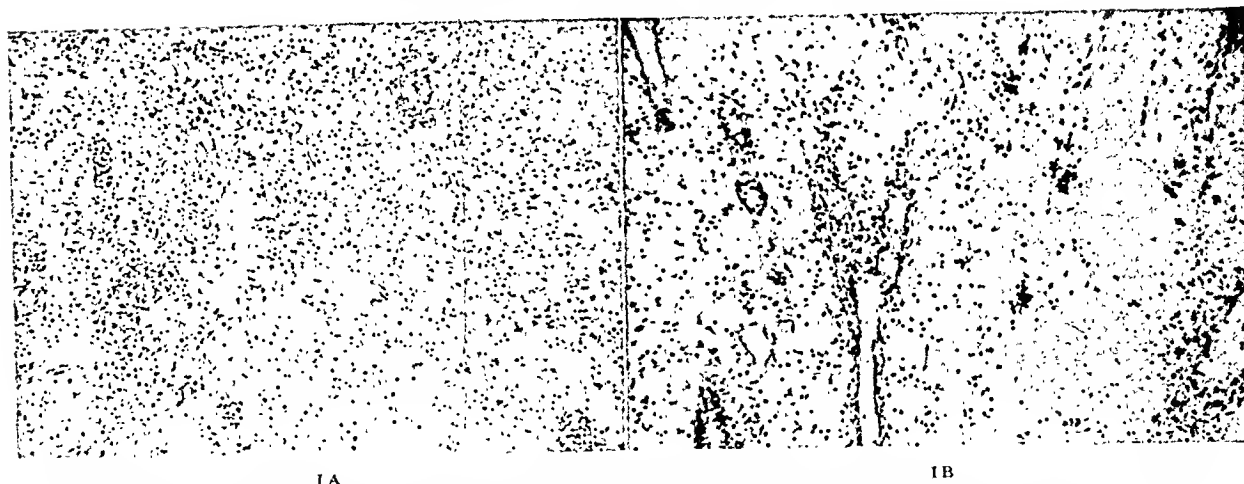
FIG. 1. A, burn granulation tissue. B, burn granulation tissue after application of tincture merthiolate. Note the marked edematous reaction. (Photographs through the courtesy of Dr. Arturo R. Casilli.)

In debilitated persons with extensive burns the exhuberant granulations are not pared down. Whole sheets of dermatome grafts (Thiersh, thin split thickness, thick split thickness), postage stamp and checker board grafts have been cut and directly applied to the exhuberant granulations without any preparation of the recipient area. No great difference has been noted in the percentage of "takes" of grafts applied in this manner as compared with those orthodoxically applied to shaved granular areas. A similar stable covering is formed. Grafts applied to exhuberant granulations bulging above the surface level took well with no final surface elevation or bulge.

PREPARATION OF THE RECIPIENT GRANULATION SITE

Burned denuded surfaces are contaminated surfaces and are treated as such. Should a discharge be present, it is removed by continuous cold saline or penicillin-saline solutions for several days prior to operation. If the wound is infected, it is surgically prepared by a daily change of dressing with the application of a thin coating of sulfathiazole powder and a continuous wet dressing of 1:3300 aqueous azochloramide. When the infection has cleared up, treatment for several days by continuous cold saline dressings ensures a clean surface ready for grafting. If the surface is clear and no discharge is apparent when

the dressings are changed, no preparation of the recipient area or contiguous burned area is attempted. The whole undamaged skin surrounding the recipient site is prepared with antiseptics and draped with sterile drapes. The burned areas are untouched and are ready for grafting. Repeated observation has shown that when common antiseptics (merthiolate, metaphen, alcohol, iodine, etc.) are applied to healthy granulations a severe edematous reaction occurs. In those cases in which the granulations were flat, stabile, non-exhuberant and suitable for skin grafting without paring, marked edema occurred a few minutes after the local application of the antiseptics. (Fig. 1.) The antiseptics exert a strong irritant effect and marked swelling rapidly occurs. In cases in which the granulations were flush to the skin not requiring paring, paring was required after the application of the antiseptics.

Extensively burned patients tend to run a continuous spiking temperature. If large areas are exposed or the wounds are infected, the temperature may spike to 102°F. to 104°F. daily. As grafting continues and the body is resurfaced, the temperature spikes to less higher levels. When the body is almost completely resurfaced, the temperature spontaneously drops to normal. Temperature elevation probably results from the absorption of toxins from the burn surfaces as it is pres-

2A   2B

FIG. 2. A and B, extensive tar pitch burns of both legs, left hand and arm.

2C   2D
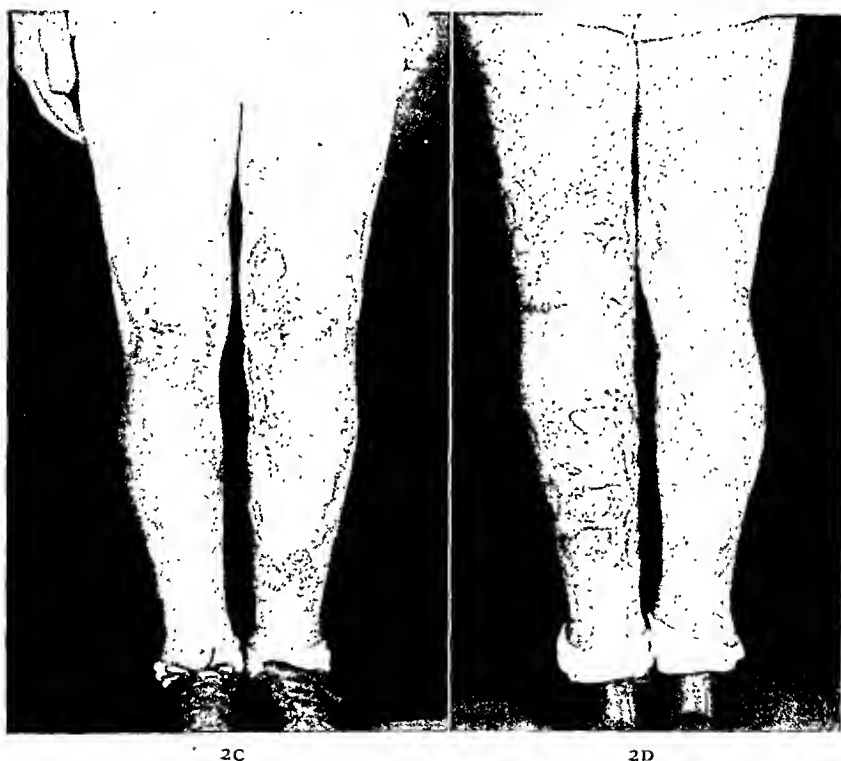
FIG. 2. C and D, postoperative result after split-thickness dermatome whole sheath and checker-board grafts.

ent even when the blood count and chemistry are normal and the burn surfaces are clean. It is further noted that extensive burns treated by tanning agents (tannic acid and gentian violet) (Fig. 2) were more toxic than those tended by vaseline-gauze occlusion dressings. A purulent discharge was usually found under the thick tan.

Small burned areas with exhuberant granulations are cauterized by tri-chloracetic acid and dressed with vaseline gauze and a pressure bandage.

TECHNIC OF OPERATION

With the aforementioned principles in mind, a quick efficient and non-shocking
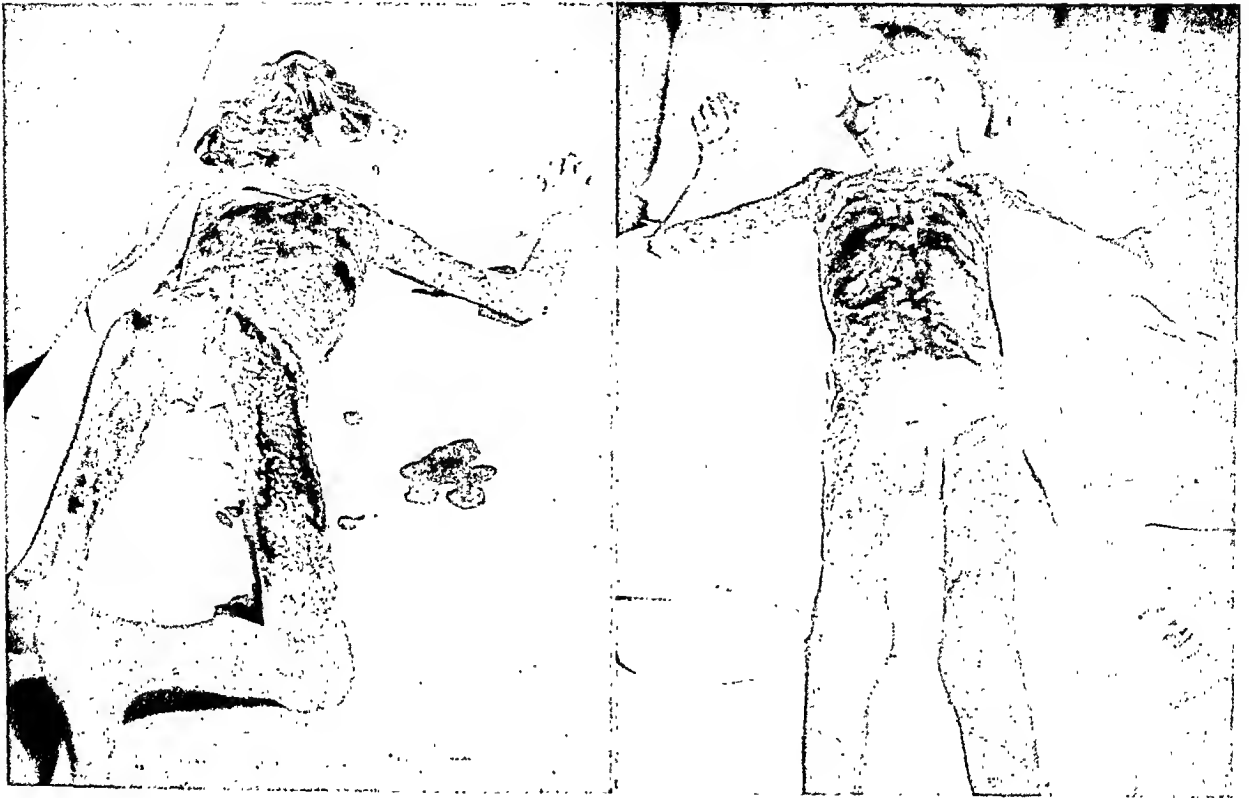
3A   3B

FIG. 3. A, extensive flame burn (dress caught on fire) of whole back, right arm and leg. B, showing extent of burn of abdominal and chest wall. Postage stamp dermatome grafts ten days after application are evident.

method of resurfacing extensive burns in cachectic patients is as follows: The patient is placed in the desired position on the operating table. The donor areas are surgically prepared and draped. Non-sterile assistants remove the dressings from the denuded recipient areas and the part is simply draped with sterile sheets. Antiseptics are applied to healed areas but none are applied to the recipient site. Cement is applied to the donor areas and dermatomes (several are employed). When the cement is dry, gas and oxygen are administered and the grafts are cut. (Two to four drums may be cut in a few minutes.) The anesthetic is discontinued and the donor sites dressed by sulfathiazole powder, vaseline gauze and pressure dressings. The grafts may be applied in whole sheaths or patterned after Poth,[8] Gabarro,[3] Hardy,[4] Jenny,[5] Eisenstodt[2] or Urkov[9] and applied to the recipient sites. They are merely placed in situ or may be fixed by loose running catgut sutures. Vaseline gauze and a pressure

dressing are applied. This technic offers a minimum of trauma, operating time, blood loss and anesthetic. Strict surgical asepsis is maintained on the sterile donor site. Sterile technic is also carried out on the contaminated recipient site.

The patient's present general condition and anticipated future condition is carefully appraised. A plan for surgery is established. If the skin available for transplantation is deficient or the patient's condition will not permit repeated long surgical procedures, postage stamp, checker board or strip grafts are advantageously employed. They are placed over large flat surfaces and are not employed over joints. After an interval of ten days one may observe the circumferential proliferation of these grafts. (Fig. 3.) If one estimates the patient to be capable of undergoing multiple operations, the grafting of large sheaths of skin is preferable and a better skin cover is formed. Burn scar margins are not debrided. Secondary plastic procedures may

4A   4B

FIG. 4. A and B, extensive chemical burns (nitric and sulfuric acids) of whole face, ear, neck, arms and legs.

5A   5B
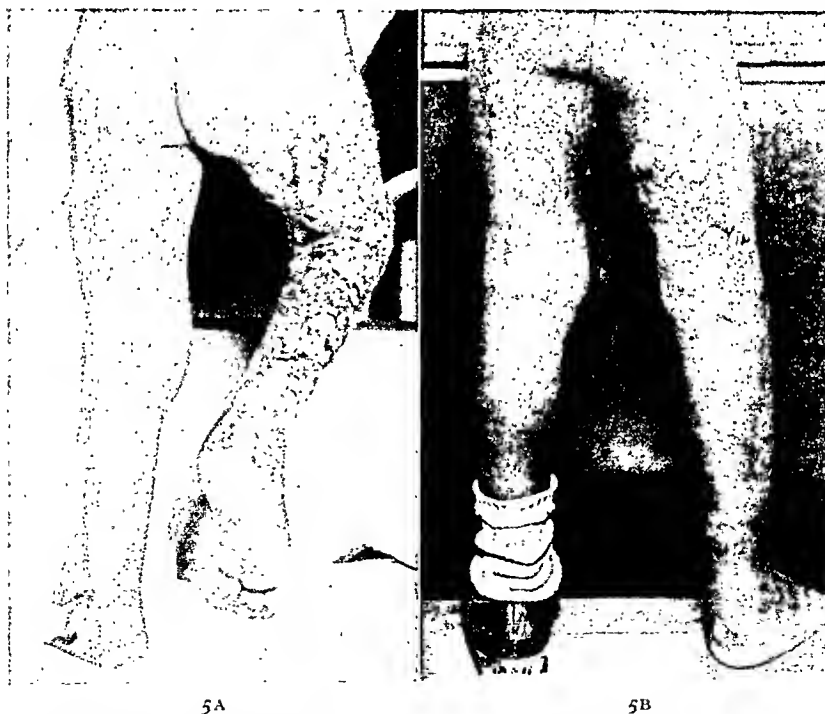
FIG. 5. A, extensive flame burn of right leg showing contracture deformity (pinch grafts had been applied to the popliteal fossa.) B, postoperative result after excision of all contractures and exhuberant tissue with repair by whole sheaths of split-thickness dermatome grafts.

be performed when the patient is better able to tolerate surgery.

A set formula cannot be applied to each case. One must modify his technic to meet the situation. With the above technic successful end results have been obtained in serious burn cases. The greater part of each graft has taken successfully. Clinically no difference has been observed in the percentage of "take" or quality of the final graft cover between grafts applied directly to exhuberant granulations and those applied to pared granulations.

Successful homogenous transplantations of pinch grafts with microscopic verification has been recently reported by Mandl.[6] This will undoubtedly stimulate further study and experimentation in the field of homogenous grafting. (Figs. 4 and 5.)

TROPHIC MANIFESTATIONS

Several weeks after a severe burn has healed vasomotor disturbances occur in those areas which epithelialized spontaneously. These sites assume a purple-reddish hue and are dry and scaly. Patients complain of severe burning and itching. Strangely enough these manifestations are not present in those areas which were skin grafted. It is not uncommon to discharge a burned patient as completely healed only to find he returns a few weeks later with extensive epidermal excoriations on the re-epithilialized sites. They are caused by continuous vigorous scratching. Occasionally a generalized pruritis occurs over the whole body but is absent in those areas covered by large sheaths of grafts. Olive oil, anti-pruritic lotions and vitamin B

complex therapy are helpful to tide the patients over these episodes. The intensity of the symptoms diminish with time.

CONCLUSIONS

1. A rapid efficient non-shocking method of resurfacing extensive burn surfaces in moribund patients has been described.

2. Common antiseptics (merthiolate, metaphen, alcohol, iodine, etc.) are strong surface irritants causing a severe edematous reaction when applied to flat, stabile non-exhuberant granulations. In moribund extensively burned patients it is believed that the use of these antiseptics is contraindicated in the preparation of the granular recipient site.

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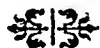
BILIARY SURGERY THROUGH TRANSVERSE INCISION

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THE following is a report of 100 consecutive gallbladder operations taken from the files of St. Vincent's Hospital, Green Bay, Wisconsin. In each of these cases the technic used was identical. (Tables i, ii, and iii.)

TABLE I

Sex	Per cent	Hospital Days	Per cent
Male.........	19	Under 10 days	66
Female.......	81	Over 10 days	34

TABLE II

Age	Per cent	Pathology	Per cent
15 to 30 yr.	15	Cholelithiasis	63
30 to 60 yr.	76	Choledocholithiasis	2
60 to 75 yr.	9	Cholecystitis	35

TABLE III

Mortality	Per cent
Cerebral hemorrhage—10th postoperative day..	1
Cerebral hemorrhage—13th postoperative day...	1

Additional surgery performed during the same hospitalization period which was not appendiceal was as follows: one bilateral varicose vein ligation, one umbilical hernia, one thyroidectomy and one hysterectomy.

A transverse incision was employed extending from about 7 cm. above the umbilicus, in the midline laterally, to the rib margin. The rectus sheath and muscle were incised transversely as was the peritoneum. After exploring the liver, stomach, intestines and the common duct the gallbladder was grasped and lifted up into the incision. The cystic duct and artery were ligated separately with No. o chromic catgut. No drainage was employed except in the two cases of choledocholithiasis in which a "T" tube was utilized. The anterior rectus fascia was closed with interrupted No. 30 quilting cotton. Interrupted dermal sutures were used to close the skin.

The patients were allowed out of bed the second to third day. They were comparatively comfortable. The lessened pain was due to decreased incidence of injury to the spinal nerves, the absence of a drain and much less tension on the incision. In checking this group we found no instance in which the cotton sutures were extruded from the wound and no case of wound dehiscence. The tendency toward keloid formation seemed to be decreased and there were fewer instances of tenderness along the incisions than when other types of incisions had been employed. No postoperative hernias or bulging of the abdominal wall occurred, as is too frequently seen in other incisions in which there are more spinal nerves cut.

Upon the whole the patients in this group had fewer complaints than those in any similar group observed in which a different technic was employed. The incidence of postoperative hernias following cholecystectomy is generally reported by many surgical clinics as varying from 10 to 20 per cent. This is due to many causes, namely, severance of the spinal nerves, infections in the wound, insertion of a drain and increased tension on the hockey stick vertical or diagonal incisions.

Drains should be employed only in cases of abscess formation or free pus inasmuch as they increase the patient's discomfort and predispose to the development of adhesions and postoperative hernias. It appears that the use of cotton for fascial closure will aid in preventing those few cases of wound disruption which occasionally occur in debilitated subjects. As far as exposure is concerned it frequently is

better with a transverse incision than when other types of incisions are used, all of which cut the spinal nerves. Gas pains were exceptionally rare in this series and it is believed were due, in part at least, to lack of irritation from a drain.

CONCLUSIONS

A transverse incision has the following advantages: 1. The wound closes naturally with less tension; 2. the incision is more comfortable. 3. it provides earlier ambulation and more rapid convalescence with shorter hospital confinement. 4. there are less postoperative pulmonary complications because deep breathing is less restricted; 5. the possibility of postoperative herniation and evisceration is decreased; 6. such an incision leaves a smoother, less sensitive scar.

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At present the operative mortality of total pancreatectomy is high even in skilled hands. However, there is no other suitable treatment for extensive cancer of the pancreas. Postoperative diabetes occurs and the average patient requires some 50 units of insulin daily to overcome the metabolic effects of diabetes on an average diet. This patient also should be given 15 Gm. of pancreatin (or its equivalent) daily to help in the proper digestion of fats and proteins. The average patient tolerates carbohydrates well but should be on a low fat diet if he wishes to enjoy an uneventful postoperative convalescence. (*Richard A. Leonardo, M.D.*)

Case Reports

VOLVULUS OF THE SMALL INTESTINE REQUIRING MASSIVE RESECTION*

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VOLVULUS of the small intestine alone is uncommon and relatively few reports of this condition have appeared in the literature.[1] With no history of a previous operation resulting in adhesions no abdominal distention or classical signs of intestinal obstruction, the diagnosis is difficult and often impossible. Nevertheless, the recognition that a surgical emergency exists becomes quite evident.

Various etiologic factors have been shown to exist and occasionally there are instances in which no definite cause can be determined. In the series presented by McKechnie and Priestley there was a preponderance of male patients; ages ranged from the newborn to seventy-eight years of age, with the greatest incidence occurring in the third decade of life. In all cases reported there is a partial fixation of one segment of the bowel with normal mobility of another segment, allowing rotation of the intestine around the base of the mesentery with formation of a volvulus.

Contributing to this mechanism may be congenital anomalies, Meckel's diverticulum, malrotation of the large intestine, unusual length and mobility of the mesentery of the small intestine, exomphalos, peritoneal adhesions (congenital or acquired),[2] mesenteric cysts, habitual constipation and chronic intestinal stasis.

CASE REPORT

A white woman, twenty-three years of age, was admitted to the hospital on January 19, 1945. Two days previously she was seen in the out-patient department complaining of severe upper midline, abdominal, cramp-like pain. The pain came on suddenly, approximately nine hours before admission, and was intermittent in its severity. It was followed by nausea and frequent vomiting. Defecation had occurred a few hours before admission.

She had her onset of menses at the age of thirteen. Her periods were always regular, occurring every twenty-eight days and lasting for four or five days. Her last menstrual period was approximately three and a half weeks prior to admission to the hospital. She had never been pregnant. There was no history of recent upper respiratory infection and no urinary symptoms were present.

Approximately one month before admission she had an attack of upper abdominal pain which came on suddenly and which was associated with nausea and vomiting. The symptoms were followed by moderate anorexia and gradually subsided over a period of one week. Meanwhile, she had felt physically normal. Defecation had occurred regularly and the stools had been of a normal character.

Physical examination revealed no masses and no special rigidity of the abdomen but she did complain of tenderness when pressure was made in the epigastrium. Emesis of bile-colored liquid occurred during the examination. Vaginal examination revealed a normal uterus and normal adnexae. The temperature, pulse, blood pressure, respirations, blood count and urinalysis were essentially normal. The diagnosis of pylorospasm was made and she was given $\frac{1}{150}$ gr. of atropine. This brought relief twenty minutes later and the patient was well enough to be discharged from the hospital.

A few hours following her dismissal from

the out-patient department her symptoms returned but she sought no medical care until 2 A.M. on the day of admission, at which time her physician gave her 1½ gr. of morphine sulfate. She obtained no relief and was sent to the hospital for admission.

On admission at 3 A.M. the patient was found to be suffering from excruciating upper abdominal pain, nausea and vomiting. Her blood pressure was 124/90, pulse 112, temperature 97.6°F. and respiration 22. Her pupils were constricted but otherwise the head and thorax showed no abnormality. The abdomen was flat and quiet and did not move with respiration. General abdominal tenderness and rigidity to a marked degree were present at 6 A.M. The patient suddenly presented the picture of shock. Her blood pressure was not obtainable and her pulse was 110, temperature 98°F. (per rectum) and respirations 24. Urinalysis showed acid reaction, specific gravity 1.031, albumin 2 plus, sugar 1 plus or 1.11 per cent and acetone 1 plus. Diacetic acid was absent. Microscopic examination was essentially negative. Her blood count was as follows: red blood cells 4,160,000; hemoglobin 41.3 per cent, or 5.9 Gm.; white blood cells 28,900; segmented neutrophils 73; non-segmented neutrophils 24; lymphocytes 3.

The diagnosis of acute hemorrhagic pancreatitis or ruptured peptic ulcer was made. The patient was given 500 cc. of plasma and 1,000 cc. of whole blood. During the period of shock the pain seemed to diminish and shift to the lower abdomen. By 2:15 P.M. a firm, tender swelling was apparent to inspection as well as palpation in the lower abdomen. This gradually increased in size, filling the lower half of the abdomen and presenting mobility, but no peristaltic sounds were heard. At 2:40 P.M. under sodium pentothal and local anesthesia a right rectus incision was made 5½ inches in length opposite the umbilicus. The abdomen contained a large amount of serosanguineous fluid. Several loops of dilated, blood-filled, gangrenous small intestine appeared immediately. The involved loops of bowel were delivered from the abdomen and by gentle palpation, the mesentery of the small intestine was found to be twisted upon itself. There was a mesenteric band originating from the mid-portion of the base of the mesentery and attaching itself to the mesenteric border of the bowel which had to be severed

FIG. 1. Gangrenous small intestine measuring 235 cm.

before detortion could be accomplished. The proximal 5 to 6 inches of jejunum and terminal 5 inches of ileum appeared to be normal but the intervening small intestine, as well as the mesentery, showed massive infarction with necrosis of the bowel wall. The entire mesentery of the small intestine was twisted three times upon itself in clockwise fashion. Following detortion only the proximal jejunum and terminal ileum, as mentioned previously, showed evidence of viability. Accordingly, the involved gangrenous bowel (Fig. 1) was resected and an end-to-end aseptic anastomosis of the remaining jejunum and ileum was done. The stomach, entire colon and appendix were visualized and appeared to be normal. Five Gm. of sulfanilamide crystals were placed in the abdominal cavity and the abdomen was closed without drainage. The postoperative diagnosis of volvulus of the small intestine was made. Two hundred thirty-five cm. of small bowel were resected, allowing approximately 18 inches of small bowel to remain.

During the operation the patient received 500 cc. of glucose in distilled water and 3 units, or a total of 750 cc., of plasma. Drop ether supplemented the local and pentothal anesthesia.

The patient's postoperative course was supported by the following measures: (1) use of rectal tube; (2) continuous Wangensteen suction; (3) 2,000 cc. daily for forty-eight hours of amigen; 1,000 cc. glucose in normal saline; (4) plasma; (5) blood; (6) cevitamic acid, 100 mg. daily, thiamine chloride, 100 mg. daily; and (7) pantapon for pain.

Following the operation her temperature, taken per rectum, rose to 102.8°F. and gradu-

FIG. 2. X-ray showing stomach and remaining small intestine.

ally returned to normal by the eleventh postoperative day. On the third postoperative day defecation occurred. On the fourth day a liquid diet was started; on the fifth day a semi-liquid diet was given. A light diet was given on the seventh day; on the ninth postoperative day the patient was allowed out of bed. On the tenth day purulent drainage came from her incision which entirely disappeared five days after its appearance. She was placed upon a non-residue diet and was dismissed on her seventeenth hospital day.

Her nutritional state has been maintained quite satisfactorily. Her weight before operation was usually 114 pounds; twelve months after operation it was 111½ pounds. Her appetite has been good and when she follows her prescribed diet (high carbohydrate, high protein, low fat, supplemented with vitamins), defecation occurs only once daily, the stool being normal in character. Digression from her diet would cause frequent defecation of partially digested food. There has been minimal abdominal discomfort.

During the first eight postoperative months she tired easily. Recently she stated that she felt better and had a greater sense of well being than she had experienced preoperatively.

Estimations of blood sugar, non-protein nitrogen, total proteins, chloride, albumin and globulin were made twice during her postoperative period and were within normal limits except for the chlorides which were low at first and later approached normal.

Complete blood counts were repeatedly satisfactory. Her last count, sixteen months postoperatively, showed red blood cells 4,030,-000, hemoglobin 11.5 Gm. and white blood cells 4,400, with a normal differential. Her sedimentation rate has been normal.

COMMENTS

Treves states that in 100 cases the average length of the small intestine in the adult male was 22 feet and 6 inches and in the adult female, 23 feet and 4 inches. He said, however, that it varies very much, the extreme in the male being 31 feet and 10 inches, and 15 feet and 6 inches. The term massive resection[3] is applied to those cases in which 200 cm. or more of small bowel has been resected. This generally is estimated to be one-third the total length of the small intestine.

Obviously, the amount of small intestine resected has a definite bearing upon the postoperative morbidity and mortality but the amount of small bowel that remains following resection should be the factor determining the ultimate nutritional status of the patient. Prioleau states that, discounting the operative risk and postoperative complications, a patient may be expected to regain a normal nutritional status following the removal of 33 per cent of the small intestine and that 50 per cent is given as the upper limit which may be borne with a possible satisfactory outcome. A greater loss than this is followed almost invariably by serious nutritional disturbances of varying degrees.

The exciting cause of volvulus in this instance was the presence of a mesenteric band acting as a central point of fixation around which the mesentery became twisted.

It can be safely assumed that preoperatively this patient had approximately 325 cm. of small intestine (considerably shorter than the average) exclusive of the duodenum and that postoperatively she has by actual measurement 90 cm. (Fig. 2) of small intestine which demonstrates that she has sustained a loss of 72.3 per cent of small intestine. Yet her present nutritional status compares quite favorably with that of any average normal adult as determined eighteen months postoperatively.

It is our opinion that the total length of jejunum and ileum combined were appreciably less than 90 cm. immediately postoperative. Yet one year after operation (Fig. 2) unquestionable dilatation and hypertrophy are evident, bearing out the observations of West et al.[4] This patient, too, has demonstrated her ability to assimilate carbohydrates well, proteins less well and fats poorly.

Individuals presenting extensive pathologic processes (ileitis, adhesions with obstructive symptoms) involving the small intestine might presumably survive extensive corrective resection today with our present postoperative supportive measures, which include adequate administration of protein, blood plasma and vitamins, than could be hoped for a few years ago.

SUMMARY

A patient requiring* massive resection (approximately 72 per cent) of the small intestine has been presented. At the present time this patient is enjoying normal health.

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* This patient moved to the Hawaiian Islands, married and became pregnant. According to a communication from her physician, Satoru Nishijima, m.d., her weight was well maintained during her pregnancy. I received a note from the patient stating that on March 25, 1947, she was delivered of a baby boy weighing 7 pounds and 4 ounces. She stated that the child was well developed. Her weight was being maintained and she was getting along very well. A recent communication dated December 29, 1948 from the patient's physician states that the patient's weight is 112¼ pounds. Laboratory examination shows red blood cells, 5,090,000, hemoglobin, 88.2 per cent; white blood cells, 9,350. Her general health is good. This represents her status four years postoperatively.

MALIGNANCY IN THE MALE BREAST

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New York, New York

GILBERT, in a recent article, gives credit to Gramiscus Arcaeus (1493–1573) and mentions several others antedating Thomas Barthomius to whom Warfield and numerous others have given credit for first mentioning cancer of the male breast. Fabricus Hildanus (1537–1619) described a single case of male breast cancer while Louis Heister, the famous German surgeon, described male mammary cancer at length in his inaugural dissertation. In the latter part of the nineteenth century the works of Horteloup and Poirier were the first to record systematic studies many investigators, such as Warfield who reviewed the known cases and added observations of his own. Recently Wainwright made an extensive review of the literature and added new material. He reported 418 cases with an examination of the pathologic material in 79.

It is generally known that carcinoma of the male breast is a rare occurrence but as Sarnoff points out despite the fact that it is more readily recognizable and is diagnosed earlier in the male because of the absence of surrounding fat and glandular tissue, once present it is more apt to recur in the male than in the female and has a higher mortality rate. He believes that the reason for this may be that there is less of a lymphatic barrier in the male as the distance is much shorter between the nipple and chest wall as well as the viscera. Sarnoff reported that for every cancer of the male breast there are one hundred cases of breast cancer in the female while Williams, in a series of 2,422 neoplasms of the breast, found 2,397 in women and 25 in men. These findings are further verified by a recent personal communication with John F. Erdmann who reports that among his series of 700 breast cases seven were in

men, i.e., 1 per cent. In our own series of 706 malignant breast tumors five cases were carcinoma of the male breast, or 0.7 per cent. (Fig. 1.) At Memorial Hospital from 1918 to 1925 Coley reports 4,000 cases of malignant breast tumors of which only twenty-six were among men, twenty-five being carcinoma and one sarcoma.

A series of cases collected by Judd and Morse showed 1,751 cases in females and seventeen in males. It is interesting to point out that the United States census report of 1900 stated that the incidence of mammary carcinoma in the male was 0.7 per cent as compared to 15.7 per cent among females. The ratio of male breast carcinomas to all male cancers (Table i) ranges from 0.38 to 1.5 per cent. The relative occurrence in the breasts of both males and females (Table ii) has been variously reported. Fitzwilliams says that in 296 recorded cases of carcinoma of the male breast 143 occurred on the left side and 148 on the right while in five the condition was bilateral. In the Judd and Morse series the left breast was affected in ten cases and the right in seven. The writer's case occurred on the left side.

It has been shown that mammary carcinoma occurs a few years later in the male than the female although Blodgett reported finding it in a boy twelve years of age and Bryan in one fourteen years and eight months. In Lunn's report the oldest patient was ninety-one years. In the cases of Judd and Morse the oldest patient was seventy-two and the youngest thirty-eight, the average age being 52.6 years. Eight of of the seventeen male patients were in the fifth decade. The writer's patient was sixty years of age. Wainwright reported an average of 52.6 years in the male and forty-five to forty-nine in the female. Sachs'

series revealed an average age in the male of 57.17 years, the youngest patient being twelve and the oldest eighty-six.

Carcinoma of the male breast was thought to be predominant in the white race because of reports from institutions in

ported in negroes; Lewis and Reinhoff recorded three of 188 cases, and in Sachs' series of 205 cases 178 were in white patients, nine in negroes and one in a Chinese. The writer's patient was Italian.

A search of the literature reveals the

N.Y. POST GRADUATE MEDICAL SCHOOL & HOSPITAL SERIES

BENIGN AND MALIGNANT BREAST TUMORS
(1138)

MALIGNANT BREAST TUMORS
706 (69.7%)

BENIGN BREAST TUMORS
432 (30.3%)

5 MALE BREAST CARCINOMA - 0.7% OF ALL CARCINOMA OF THE BREAST

FIG. 1. Breast tumors 1932 to 1941, inclusive; New York Post-Graduate Medical School and Hospital series.

which the majority of patients were white. It has been reported, however, in almost all nationalities. Ludlow cited a case in Korea. Wainwright cited a case recorded by Sirrha

variability in the known duration of malignant breast tumors before operation. A report by Owens and Eisendroth gives the history of a patient with a tumor of the

TABLE I

INCIDENCE OF CARCINOMA OF THE BREAST IN THE MALE

Authors	In Relation to All Other Male Cancers (per cent)	In Relation to Female Breast Cancer (per cent)
Sachs' series (1940)	0.38	1.32
Williams (1889)	1.0	0.7
Peek and LeFevre (Gilbert, 1933)	0.41	1.25
Pondville Hospital (1940)	0.25	
U. S. census report (1900)—Moore	0.7	
Schreiner (1932)	1.25	
Deaver and MacFarland (1917)	1.5	
England and Wales Census (1926)—Gilbert		
Schuchardt (1884)	....	0.08
Judd and Morse (1926)	....	2.0
Judd and Sistrunk (1914)	....	0.9
Rosh (1931)	....	3.0
Keyser (1904)	....	2.0
Yamamoto (1911)	....	0.7
	....	1.08

TABLE II

SIDE INVOLVED IN CARCINOMA OF THE BREAST IN MALES AND FEMALES

Author	No. of Cases	Right Breast	Left Breast	Bilateral Involvement
Sachs' series (1940)	205	99	106	3
Cumston (1920)	266	139	126	1
Fitzwilliams (1924)	296	148	143	5
Wainwright (1927)	336	163	170	3
Gilbert (1933)	47	20	26	1
Lane-Claypon Females (1924)	13,909	6,907	7,002	
Lane-Claypon Females (1928)	1,767	809	958	

breast for thirty-five years while Moore records the case of one who had a tumor for only two weeks. Judd and Morse cited a case of a patient with a history of a tumor for eighteen years although increase in size had occurred for only two years preceding operation.

The symptomatology of pain, bloody discharge from retraction of the nipple and ulceration vary with the type, situation and extent of the carcinoma. The variations are similar to those of carcinoma

in a native East Indian and one by Welch in Kiknyw of British East Africa. Moustardier described two cases in Madagascan natives. Many examples have been re-

found elsewhere in the body. That ulceration in the male breast is more common than among females is readily understood when one considers the normal relative difference in the distance from the overlying skin in the two sexes. Cheatle and Cutler stated that ulceration is a common finding and Gilbert recorded the presence of ulceration and nipple retraction in 29 per cent of the subjects. Speed found nipple retraction in 50 per cent, Williams in 73 per cent. Gilbert stated that pain was present in 27 per cent of the patients. Judd and Morse attributed nipple retraction to the small amount of glandular tissue present in the male breast. Bleeding from the nipple was found to occur in 8 per cent of the cases according to Gilbert while Speed reported it in 50 per cent and Williams in 73 per cent. A review of single cases in the literature shows its presence in 24 per cent. There was no history of bleeding in the writer's patient.

There are several causative factors for carcinoma of the male breast to be considered. Trauma as an etiologic factor for this disease rests upon the history given by the patient. Gilbert states that fourteen, or 29 per cent, of the patients in his series had a previous history of injury while two patients were accustomed to exerting pressure against the chest wall in following their usual occupations. Ewing insists that a relationship between trauma and breast tumors may be assumed to have a causal significance only if the breast can be shown to have been previously normal and the injury to have been severe enough to have caused interstitial hemorrhage and solution of continuity of the breast duct; also that there must be some indication of continuity of symptoms between the trauma and the appearance of the tumor and that even in those cases one can only maintain a probable relationship. Knox also warns us that it would be as inaccurate and unscientific to ascribe the origin of cancer to a single blow as it would be to judge the duration of a tumor of the breast from the patient's statements.

Murphy, on the other hand, makes a radical statement that the breast is the only organ in the body where cancer will develop following a single mild trauma. Concerning the influence of trauma, reports in the literature vary greatly. Schuchardt considered 25 of his 219 cases to be due to contusions or mechanical causes. In only one of Judd's series of seventeen cases was trauma mentioned as a possible causative factor. Wainwright reports the relationship so frequently that he believes it must be taken into consideration as a cause of cancer, at least in the male breast. Breast carcinomas have been observed in shoemakers, carpenters and postmen.

It appears that heredity is of secondary importance as a causative factor in male breast cancer. Many explanations are given to account for the relative rarity of cancer of the male breast as compared with cancer of the female breast. Development of the gland is similar in both sexes until puberty. In the female the course is then one of great functional activity and cyclic changes whereas in the male the gland remains relatively stationery with less variation in the anatomic structure. The part endocrinology plays may also be a factor. However, this inherent difference in the functions of the gland is the most commonly accepted explanation. The rare occurrence of cancer of the male breast is in accord with the general rule that cancer seldom arises in vestigeal structures.

CASE REPORT

Mr. J. R., a sixty year old white man, was first seen by the author on October 15, 1941, complaining of a hard lump about 2 cm. in diameter in his left breast. He stated that this mass had been present for a period of two years and had not increased in size nor had it been painful at any time.

No discharge from the nipple area had ever been noted.

The past history revealed that as young man the patient often swapped chest punches with other young men. He also stated that about twenty-two years ago, while employed as a street car conductor, he was struck in the

left breast by the grab handle of a seat. Previous surgery included a left herniorrhaphy and hemorrhoidectomy about thirty-two years before and repair of a hydrocele thirteen years ago. The family history did not bring out any relevant facts and careful inquiry as to the possibility of familial cancer was negative.

Physical examination revealed a well nourished, well developed individual weighing 155 pounds. Examination of the right breast and axilla proved to be essentially negative. Palpation of the left breast revealed a rather firm, freely movable mass about 2 cm. in diameter in the nipple area. There was no discharge from the nipple area nor were there any signs of retraction. No palpable glands in the axilla were noted but there was slight swelling of the breast, with some tenderness and redness.

The tentative diagnosis was fibro-adenoma of the left breast. Approximately one week after examination the swelling, redness and tenderness practically disappeared. However, the firm mass previously described still remained. It was deemed necessary at this time to remove the mass and a simple excision was done through a thoracomammary incision at the lower angle of the breast which was about five inches in length. The mass was excised in its entirety; the nipple remained in place. Interrupted black silk sutures were used in the skin and one latex drain was inserted. The patient made an uneventful recovery. The pathologic diagnosis was medullary carcinoma of the left breast. In view of this diagnosis radical mastectomy became the procedure of choice. This was done about two weeks later after the patient, who was hesitant in consenting to further surgery, was made to realize the seriousness of his condition.

A radical mastectomy was performed on November 3, 1941. A Halsted-Willie Meyer incision was made through the skin and the superficial layers of fat. The skin edges were grasped with Kocher clamps. With Kocher clamps putting tension on the skin the knife was placed on the undersurface of the skin and dissection backward from the edge was begun, taking the subcutaneous fat off the underside of the skin flaps. Subcutaneous dissection was continued until the skin was elevated off the chest wall medially to the opposite border of the sternum, laterally to the lateral border of the scapula, inferiorly to the costal margin and superiorly to the clavicle.

Dissection of the chest wall was begun at the superior angle over the clavicular portion of the pectoralis major muscle and carried downward to the dividing line between the clavicular and sternal portions of that muscle. The pectoral muscle attached to the sternum was then cut away and all of the perforating vessels were ligated. The dissection was then carried laterally until the insertion of the pectoralis major muscle on the humerus was exposed. When this muscle was isolated, it was divided as close as possible to the humerus. The sternal portion of the pectoralis major muscle was then entirely freed from the chest wall and laid back to expose the pectoralis minor and axilla. The pectoralis minor was isolated and divided from the coracoid process. The cut ends of the distal portion were grasped with holding forceps and the muscle turned back over the clavicle.

The axillary dissection was started by dissecting the axillary contents away from the under surface of the clavicular portion of the pectoralis major at the insertion of the clavicle. This muscle was cleaned off by dissecting toward the operator. Over its outer surface the fascia (costoclavicular), which unites the outer edge of this muscle with its outer surface, was knicked with a knife all along the subclavius up to the first rib. This fascia was then divided in a horizontal fashion thus freeing it from the attachments to the chest wall. Upon completion of this a wiping outward and downward process exposed the vein and the plexus at the superior medial angle of the triangle.

The axilla was further exposed by a continuation of the wiping down process beginning well up underneath the clavicle, cephalad, to the vessels and plexus and directed downward at right angles to these structures. This was continued until the whole plexus was exposed. The dissection along the axillary vein was then begun and with a sharp curved clamp the sheath of the vein was penetrated at the point where the vein comes out from under the clavicle. The sheath was then split downward the whole length of the vein over the outer surface. The long thoracic artery was exposed, divided and ligated approximately 1 cm. from its origin from the axillary artery. The thoracodorsal nerve was preserved by isolating and ligating the artery and vein. The posterior axillary space was then cleared by lifting the
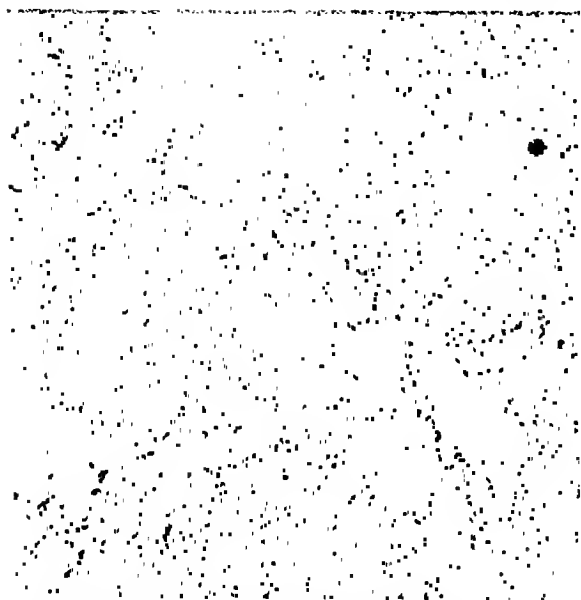
Fig. 2. Histologic appearance of breast tumor tissue in case reported showing medullary carcinoma.

vein, artery and plexus on a small retraetor and by wiping downward and outward using gauze. All bleeding points were ligated with plain, single eatgut.

The pathologie report following radieal mastectomy was as follows: (1) chronie post-operative mastitis; (2) lymph node without secondary involvement; (3) medullary earei-noma. (Fig. 2.)

The patient's general eondition was good on leaving the operating table. His pulse in the left wrist was of good quality and regular. After reacting from the anesthesia the patient was able to move his arm at the shoulder with some pain. During the eoursc of his hospitaliza-tion motion in the shoulder joint was good and gradual movement was eneouraged. The patient was discharged from the hospital after an uneventful recovery approximately ten days following operation.

He reported regularly for treatment and two months postoperatively, he weighed 155½ pounds and was doing his regular work as a gardener. The operative area was well healed with no evidence of recurrence and no axillary adenopathy. He complained of a "sticking pain" in the operative scar but despite that his physical condition was excellent. In October, 1942, his general and local conditions were satisfactory with no weight loss. A year later, in October, 1943, he entered the hospital for a left epididymectomy. No malignancy was found and he recovered successfully. Two

months later an electrocardiogram, chest x-ray, blood and urine analyses were all normal.

COMMENTS

The sueeessful restoration of this pa-tient to normal health with normal fune-tion of the remaining parts is the most im-portant and gratifying result of a eomplete and thorough radieal breast operation. When last seen in the late spring of 1947, the patient showed no evidenee of reeur-renee and his general health has been exeellent. His appetite and digestion have been normal, with no weight loss. He has eontinued to work daily and motion in his left shoulder girdle is exeellent. (Figs. 3 and 4.)

Although there were no axillary nodes palpable on preoperative examination, the breast was swollen, red and tender and in view of the pathologie diagnosis following simple exeision, axillary disseetion was thought advisable. Williams reports that axillary metastases are present in 63 per eent of the eases while Speed gives their incidenee as 60 per eent, Joll as 60 per eent, and Wainwright as 68 per eent. Twenty-five per eent of the patients in Gilbert's series presented axillary nodes. In 48.3 per eent of Saehs' patients they were evident at the initial examination.

In regard to operability a review of seventy-five eases in the literature showed 58 per eent of the patients to be operable. Gilbert reported 58 per eent of his patients as operable and Bailey, 66 per eent. Saehs' reports show that at the time of examina-tion 73.8 per eent of his patients were eon-sidered by the surgeons to be operable and 18.55 per eent inoperable; in 7.65 per eent no mention was made as to operability.

Male breast earcinomas are elassified histologieally in the same groups as ear-einoma of the female breast, namely, adenoearcinoma, seirrhous earcinoma, med-ullary earcinoma and earcinoma simplex. Sarcoma, squamous eell and basal eell ear-einoma are rare. Wainwright remarked that in his histologic studies he was unable to distinguish between male and female

FIG. 3. Patient, J. R., six years following radical dissection, demonstrating non-limitation of motion in the left upper extremity.

FIG. 4. Patient, J. R., six years postoperatively showing well healed mammary scar without recurrence.

breast carcinomas. Sachs reports in 178 cases the predominant pathologic finding was that of adenocarcinoma (40.7 per cent). Scirrhous carcinoma was present in 19.09 per cent, medullary in 9.55 per cent, simplex in 8.98 per cent, sarcoma in 2.24 per cent, squamous cell carcinoma in 0.56 per cent and Paget's disease of the nipple in 1.12 per cent. In Table III, Sach's pathologic findings are compared with those of Gilbert's and Wainwright's.

In a series of one hundred cases of adenocarcinoma of the breast Geschickter and Copeland reported only one case occurring in a male with generalized bone metastases. This is a rate metastatic site in the male breast. Gilbert reported that 40.4 per cent of his patients had local recurrences. Judd and Morse found the average duration before recurrence to be nineteen months whereas Williams claimed that in the male the average interval was 9.7 months and in the female twenty-six months. Local recurrences were present in 25.9 per cent of Sachs' patients. The majority took place within the first year although two patients had recurrences after fifteen years.

Clinical evidence of metastases was present in 46.3 per cent of Sachs' patients. In most instances the metastases were to the regional lymph nodes (twelve cases in the axilla, two in the supraclavicular fossa, two in the cervical region and two in the mediastinum). The brain, spinal cord and larynx were found to be involved, each in one case, while metastases to the lungs was demonstrated by x-ray examination in twenty-seven patients.

In 1892 Snow described specimens of bone in which the marrow reticulum had been replaced by a tough fibrous tissue which showed the characteristic acini of scirrhous carcinoma. Geschickter and Copeland described bone metastasis histologically as a destruction of the spongiosa and cortex by contact with tumor cells and to a lesser extent by activity of the osteoclasts absorbing spicules of dead bone. According to Geschickter and Copeland, extension is via the medullary cavity and haversian canals, beginning in the red marrow. The bones react to invasion by converting fibroblasts to osteoblasts, producing an osteoid tissue.

Paget stated that bone marrow hyperemia produces a slowing of the current within the dilated capillaries, thus favoring adherence of the tumor cells to the endothelium. Snow thought that cancer cells were in the general circulation and de-

TABLE III

PATHOLOGY IN CARCINOMA OF THE MALE BREAST

	Sachs' Series (178 cases) (per cent)	Wainwright (78 cases) (per cent)	Gilbert (47 cases) (per cent)
Adenocarcinoma.........	40.70	17.0	19.15
Scirrhous..............	19.09	49.0	4.25
Medullary.............	9.55	18.0	
Simplex...............	8.98	3.7	53.19
Carcinoma.............	15.73		
Gelatinous............	0.56	3.7	
Squamous cell or basal cell.................	0.56	9.0	2.13
Paget's...............	1.12		
Carcinoma (Aspiration)..	0.56	....	10.64
Sarcoma..............	2.24		
Premalignant Adenofibroma..............	1.12		
No record............	....	....	10.64

posited themselves in the bone marrow. This may account for the anemia and cachexia in the late stages of the disease. Von Recklinghausen believed the marrow to be involved first by a hematogenous spread of the cortex through the nutrient foramen. Geschickter and Copeland explained the frequent involvement of the femoral head to be due to the blood vessels in the ligamentum teres. Handley favored a lymphatic permeation, but Neal and Oshers claimed that there are no lymph vessels in the bone.

Although the incidence of carcinoma in the male breast is rare, particularly as compared with the occurrence in the female, it should be emphasized that a successful cure is dependent upon a thorough and meticulously performed radical operative procedure.

SUMMARY

1. A statistical study of carcinoma of the male breast, including incidence, age, race and the side involved, is presented.

2. The symptomatology and etiology with special emphasis on trauma is reviewed.

3. A complete case report of a male patient with a six-year cure following radical mastectomy for medullary carcinoma of the left breast is presented.

4. A survey of the literature is made in the discussion of pathology and the occurrence of metastases in the male breast.

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ADAIR and Munger studied the records of 110 patients with fat necrosis of the breast and found that in over one-half of the patients a history of trauma was not very definite. They also found that ecchymosis due to trauma had occurred in only twenty-one patients. The condition closely simulates malignancy since 65 per cent of these tumors were adherent to the skin and the nipple was retracted or elevated in fourteen cases. The authors found that almost one-third of these patients had enlarged axillary nodes which simulated the picture of malignancy even more closely. Surgeons should keep this condition in mind. (*Richard A. Leonardo, M.D.*)

HEMIPELVECTOMY IN TREATMENT OF OSTEOGENIC SARCOMA OF THE ILIUM *

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SINCE the original hemipelvectomy operation by Billroth in 1891[1] about 132 cases have been reported in the literature. In 1894 the first successful operation in which the patient survived the procedure was reported by Girard.[4] During the ensuing fifty-five years many terms have been used to describe the procedure, such as transiliac amputation, interilio-abdominal amputation or disarticulation, interpelviabdominal disarticulation, hindquarter amputation, transischiosacropubic disarticulation, interiliosacropubic disarticulation and innominate bone disarticulation.

Two primary factors must be taken into consideration in the evaluation of an operative procedure for malignant tumors, namely, the primary operative mortality and the long range end results as to cure or recovery. The disability resulting from such a procedure is considerable since the patient cannot be fitted with a prosthesis and must depend upon crutches for ambulation.

The operation and immediate postoperative mortality as reported by a survey made by Gordon-Taylor and Wiles[6] and Gordon-Taylor and Patey,[5] British surgeons, was 59.5 per cent in a series of seventy-nine cases. However, the overall mortality rate was about 36 per cent. In the past eleven years the mortality has dropped to 14 per cent.[13] In twenty-one personal cases reported by Gordon-Taylor[5] the operative mortality was 29 per cent and in his last ten cases the rate was 20 per cent. The major cause of death was shock at the time of operation or a few hours afterward. With a better knowledge of anatomy, anesthesia and methods of combating shock, the present operative mortality rate can be reduced.

Indications. Hemipelvectomy is indicated for primary malignant, osseous and periosteal tumors of the upper femur where the growth has extended to or through the hip joint and for similar tumors of the innominate bones. Large, primary malignant, soft tissue tumors of the upper thigh (involving the hip joint or extending through the obturator foramen), groin, buttock, pelvic parietes and iliac region are best treated by this type of amputation.[2,6–8,10–12]

Occasionally this radical procedure has been performed in the palliative therapy of cancer. In these cases, according to Pack, elimination of sepsis and pain and conversion of a foul-smelling, bed-ridden patient to comfort and partial activity can be accomplished in certain hopelessly advanced cases.[9]

Massive osteochondromas of the pelvis and massive plexiform neurofibromas involving the upper thigh, groin and hip joint or buttock and pelvic parietes are treated in this manner.[9,13]

It is important that an anatomic diagnosis be established by aspiration or open biopsy before radical amputation or any other form of therapy is instituted.

Preoperative Management. A complete survey is made to rule out any evidence of local pelvic parietes involvement or distant metastasis. This includes the necessary x-rays of other bones, lungs, intravenous pyelograms and barium enema, if necessary, and complete blood studies to

include blood count, serum protein determination and non-protein nitrogen. Any changes that are not normal should be corrected by the necessary measures such as blood transfusion and parenteral administration of amino acids.

The insertion of a rectal tube and a Foley catheter prior to surgery will be a great aid in localization of these important structures during surgery. These also serve in the postoperative management of the case. It is suggested that in cases of large tumors of the ilium the introduction of a ureteral catheter on the side of involvement will facilitate the localization of the ureter during the procedure and aid in the prevention of injury or inadvertent division of the ureter. The anesthetic agent used by various authors is inhalation anesthesia, continuous spinal or spinal.[5,9,13,14] Arrangements for blood transfusions should be made and completed prior to surgery and it is recommended that a minimum of two, but preferably three, liters be on hand for immediate use.

Surgical Procedure. The management and institution of methods to combat shock is paramount. As indicated by Morton,[8] reduction in the incidence of shock can be expected in gentle handling of tissues and less harm by careful and deliberate dissection rather than by unnecessary speed and slashing of tissues. Several authors believe that frequent changes in position of the patient during the operation is a contributing factor toward shock.[3,6,9]

However, it is believed that shock is primarily caused by blood, blood plasma and tissue fluid losses; secondarily, by trauma, tissue manipulation, sectioning of large nerve trunks and sudden changes in position of the patient that are necessary to carry out this procedure.

It is important to have intravenous fluids started prior to incision. Shortly after the operation is started blood transfusion is begun. The anesthetist and surgeon should be certain that the veins being used for intravenous administration are adequate.

Position on the table is variable; some surgeons begin with the patient first flat on his back as was done in this case.[8,9] The anterior portion of the incision (Fig. 1A) extended from the symphysis pubis to the anterior superior iliac spine above and
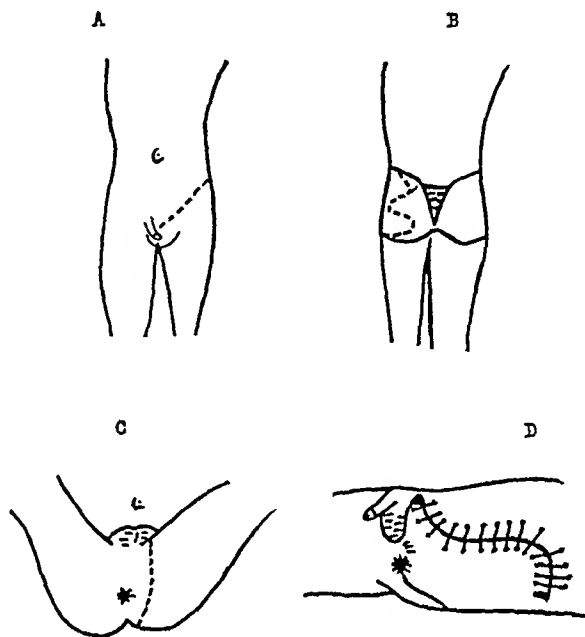
FIG. 1. A, incision for anterior portion of operation; B, incision for posterior portion of operation; C, incision for perineal portion of operation; D, wound closure with two drains.

parallel to the inguinal ligament and then along the medial border of the crest of the ilium to about the mid-point. This dissection was carried through the superficial fascia to the external oblique aponeurosis. The inguinal ligament was detached from the pubis and ilium and the rectus abdominis muscle was freed from the pubis. This frees all of the muscles of the anterior abdominal wall and permits extraperitoneal dissection. At this point the above flap was displaced upward and medially and the pelvic contents were then identified, such as the bladder, ureter, rectum and sigmoid. These structures and their peritoneal coverings were displaced and retracted medially and held out of the field by large packs and retractors.

The external iliac vessels were isolated and the artery was doubly ligated with chromic catgut and divided. The femoral

nerve was injected with 95 per cent alcohol and divided high in the iliacus muscle.

Dissection was continued, exposing the sacroiliac joint and the symphysis pubis was skeletonized. The symphysis was divided with the use of an osteotome, care being taken to prevent injury to the penis and urethra beneath the joint. The inferior ramus of the pubis and ischium were exposed at the "white line" at which point the levator ani, pelvic diaphragm and the obturator internus muscles were divided. These areas were packed off to control hemorrhage while the second phase of the operation was carried out.

The patient was then turned on his right side and the first incision was carried downward and across the top of the greater trochanter. At this point the incision was curved anteriorly for several inches and then downward toward the inferior gluteal fold. (Fig. 1B.) This dissection was carried through the skin and superficial fascia down to the gluteus maximus muscle. This posterior skin flap was dissected posteriorly to the sacral border on the left side.

The patient was returned to the original position on his back and dissection was continued anteriorly. The left lower extremity was elevated to drain out as much blood as possible before ligation of the external iliac vein was accomplished. The obturator artery and vein were doubly ligated and divided. The obturator nerve was injected and divided. After ligation of this vein the muscles of the anterior abdominal wall and the quadratus lumborum muscle were cut free from their attachment to the crest of the ilium. The iliopsoas muscle was divided high at the level of the lumbosacral crest. The sacro-iliac joint on the left was exposed and separated by the use of a chisel inserted by manual manipulation, pointing the blade obliquely lateralward. Considerable bleeding occurred at this point but was easily controlled by firm, warm packs for a few minutes. Anterior dissection now completed, the patient was turned on his right side again.

The posterior dissection was now continued, cutting the gluteus maximus muscle free from the posterior aspect of the sacrum. This muscle was not saved to be used as a flap for closure, as recommended by some authorities, because the tumor was invasive, involving the gluteus medius and minimus posteriorly and a portion of the obturator internus and pyriformis anteriorly.

The left half of the pelvis was free except for the attachment of the pyriformis, gemelli and levator ani muscles which were divided near the pectineal line. The sciatic tract was then injected and divided high up. The superior and inferior gluteal arteries and veins were ligated and divided.

The skin incision was carried from the inferior gluteal fold medially around to the perineum and then up anteriorly to join the starting point of the incision at the symphysis. (Fig. 1C.) The sacrotuberous and sacrospinous ligaments were divided and the entire left half of the pelvis and left lower extremity were freed and removed.

All bleeding points were controlled. Oxycel was placed over the raw surface of the sacroiliac joint and behind the symphysis pubis. The wound prior to this was irrigated thoroughly with saline solution; 10 Gm. of sulfanilamide powder were placed in the wound and the area was closed by mattress and interrupted sutures of chromic No. 1 catgut, bringing together portions of the iliopsoas and muscles of the anterior abdominal wall.

The quadratus lumborum muscle was sutured to the anterior groups of muscles. The remaining support to the pelvic content was obtained by suturing the subcutaneous tissues, the posterior flap to the same tissues of the anterior flap. Two long rubber drains were placed at opposite ends of the wound. The skin was closed by interrupted mattress dermal sutures. (Fig. 1D.) A snug bandage was applied.

Postoperative Management. The patient was placed in an oxygen tent for twenty-four hours. Intravenous fluids, including plasma, amigen and daily blood transfusions, were given for three days. On the

third postoperative day there was no distention and the patient was placed on surgical liquids; the diet was increased daily. The rectal tube was removed on the third day and the indwelling catheter was removed after four days but during this period tidal drainage was established and maintained. The patient had normal urinary control following removal of catheter and bowels were functioning without difficulty after the third day. The patient was given 50,000 units of penicillin every three hours for six days.

CASE REPORT

CASE I. This patient, a twenty-two year old, white male, was admitted to the hospital for the first time on January 25, 1947. In September, 1945, while returning home from overseas, he noticed pain in his left hip with radiation of the same along the inner aspect of the thigh as far as the knee. He was discharged from the service on January 6, 1946. Following his discharge the pain became progressively worse, being more severe at night. The pain was exaggerated on coughing or sneezing and was intense enough to cause limping when walking. During this period of time he was seen by several physicians and on August 16, 1946, was seen in one of the clinics at which time he complained of low back pain. Physical examination at that time was negative and an x-ray of his lumbosacral region was reported negative.

On October 29, 1946, he returned to the same clinic with complaints of left sciatica of four days' duration and pain on motion of the left hip. Recheck x-rays taken at this time revealed a tumor of the left ilium involving the supra-acetabular region with extension toward the sciatic notch. The tumor showed evidence of both an osteoplastic and osteolytic process.

On October 31, 1946, an open biopsy was taken from the mass of the left ilium. The microscopic report at that time was an osteogenic sarcoma. He was given a course of x-ray therapy from November 8, 1946 to January 24, 1947; a total of 3,528 roentgen units anteriorly, posteriorly and laterally of the left ilium. The other x-rays and examinations revealed no evidence of local or distant metastasis prior to admission here.

FIG. 2. X-ray taken January 30, 1947, showing extensive tumor of entire left ilium.

The patient was then referred to this hospital for further examination and treatment. At the time of his admission he stated that the pains were not as severe as they were before irradiation therapy. He noticed weakness of the muscles of the left lower extremity and had pain on walking. He lost only 4 pounds since the onset of his illness. He had no complaints referable to the gastrointestinal or genitourinary tracts.

Physical examination was essentially negative except for the area of the lateral wing of the left ilium. This area was fuller and firmer than the opposite side and there was limitation of motion of the left hip joint. Motion of the extremity produced pain. Abdominal palpation medial to the left iliac crest gave a sense of fullness in the pelvis in the left iliac fossa. On rectal examination there was a sense of fullness and firmness on the left near the ischial spine. There was no evidence of local lymph node involvement or local extension to the rectum or bladder.

Stereoscopic x-rays of the pelvis on January 30, 1947 (Fig. 2), revealed an osteoplastic and osteolytic process involving the posterior aspect of the left ilium extending downward toward the obturator foramen with growth occurring inward toward the pelvis. There appeared to be no soft tissue involvement in these areas. X-rays of the chest, lungs and spine were negative.

Laboratory data on January 29, 1947, were as follows: red blood cells, 4,940,000; hemoglobin, 14.5 Gm.; white blood cells, 6,900; polymorphonuclears, 68 per cent. Three days following surgery, February 23, 1947, laboratory data were: red blood cells, 4,260,000; hemoglobin, 12.5 Gm.; white blood cells, 4,100;

FIG. 3. Gross specimen of entire left innominate bone, external view; extensive tumor formation.

non-protein nitrogen, 48; total proteins, 6; blood chlorides, 480. On February 6, 1947, blood calcium was 8.7 and alkaline phosphatase was 7 Bodansky units. Urinalysis was normal and blood serology, negative.

On February 20, 1947, a left hemipelvectomy was performed under general intratracheal anesthesia. The patient received 6 pints of whole blood during the operative procedure and 1 pint following surgery. The lesion had not extended to involve the urinary tract or any of the pelvic parietes.

Postoperative intravenous pyelograms revealed normal function from both kidneys and no obstruction or distortion of the left ureter was seen. Postoperative x-rays of the pelvis revealed a complete removal of the left innominate bone from the symphysis pubis back through the left sacro-iliac joint. The soft tissue of the stump area revealed no evidence of tumor mass.

Examination of the gross specimen (Fig. 3) obtained after disarticulation revealed the muscles surrounding the wing of the ilium to be pale in color, edematous and to contain gritty, hard, direct extensions of the neoplastic mass involving the ilium.

The main tumor mass involved the entire wing of the ilium and was expansive. It measured 13 cm. in diameter. It did not appear to involve the ischium or the ramus of the os pubis. The greatest expansion of the mass was externally on the wing and here was a large, dome-shaped mass measuring 12 by 15 cm. The cortex covering this mass was paper thin.

There was another rather soft mass in the region of the sciatic notch which bulged internally and measured approximately 2 by
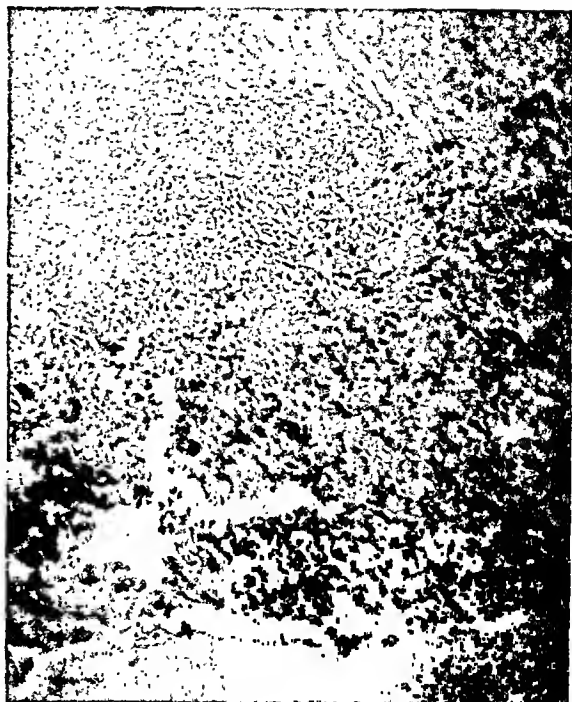
FIG. 4. Microphotograph of tumor of ilium.

1.5 cm. On cross section there were large, clear, cartilaginous foci measuring up to 4 mm. in diameter; cystic spaces, some of which were filled with blood; areas of softening and necrosis; and an irregular network of bone spicules.

Microscopically, examination (Fig. 4) of the sections presented an extremely diverse histologic pattern. Portions were seen in which irregular, poorly formed spicules of bone were being laid down by extremely active osteoblasts. In these areas osteoblastic activity was marked. The stroma in these areas appeared rather myxomatous.

In other areas there was a large, extremely cellular mass of wildly growing, deeply stained hyperchromatic cells arranged in no specific pattern. Individual cells were very large and irregular and possessed a large amount of basophilic cytoplasm. Nuclei varied markedly in size, shape and staining capacity. Most of them were huge, oval to round and contained two or more nucleoli. Areas of hemorrhage were seen as were tumor cells which were seen free within the vascular lumina. The pathologic diagnosis was osteogenic sarcoma.

The drainage from the wound was serosanguineous in character and was moderate in amount during the first five days. The drains were removed at the end of six days
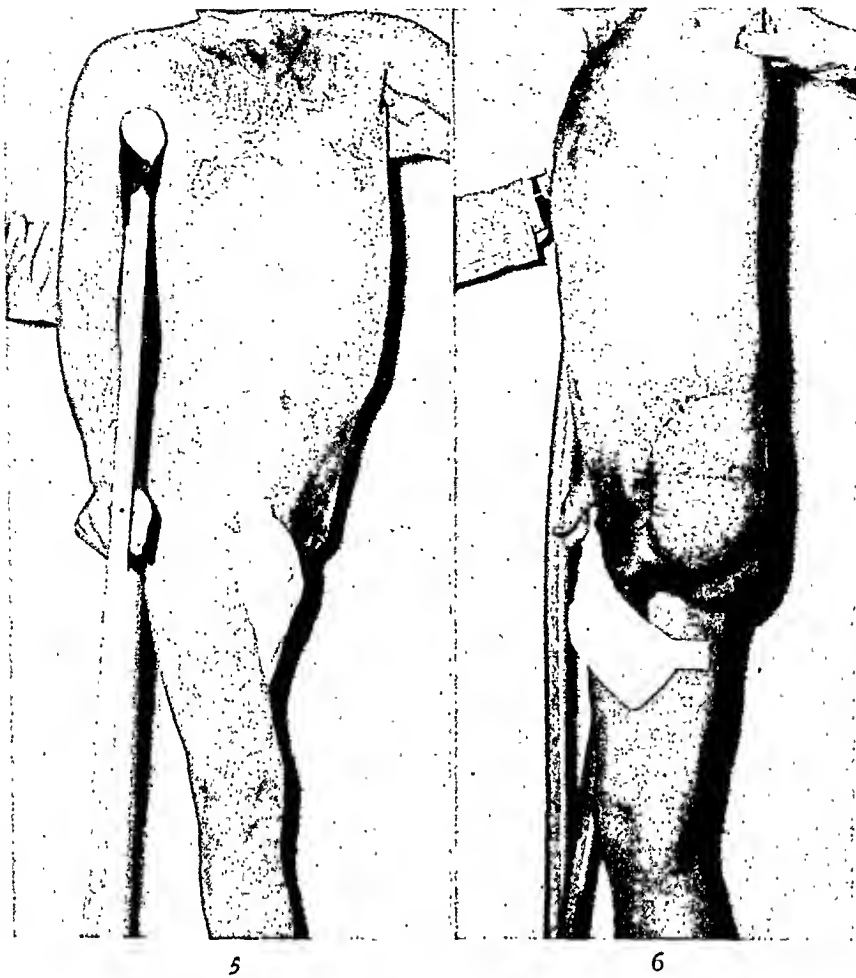
FIGS. 5 and 6. Patient on the sixteenth postoperative day.

and the wound healed by primary intention except for drainage at both ends. The patient was ambulated on the tenth postoperative day. His activities gradually have been increased. (Figs. 5 and 6.) There was no evidence of necrosis of the skin flaps. The wound area was supported by an Ace bandage dressing.

At the present time (June, 1947) there is no evidence of local residual tumor or demonstrable distant metastasis.

COMMENTS

The end results of this procedure will be improved when surgeons acquaint themselves with the fact that the operation can be undertaken with relative safety and that operative mortality is now 14 per cent.[5,9,13]

This figure can be lowered by the institution of good preoperative, operative and postoperative methods to combat shock. A

complete knowledge of the anatomy involved coupled with good basic surgical principles will carry the well grounded surgeon through such a procedure. In this way more patients will be offered a chance for cure, especially in certain types of malignancies which they are now denied by conservative measures.

Benign tumors such as neurofibromas, benign giant cell tumors, giant osteochondromas and chondromas offer the best prognosis. The chondrosarcomas[9,13] offer the most favorable prognosis for the malignant bone tumors. Less favorable in prognosis are the well differentiated soft tissue sarcomas.[9,13,6]

Osteolytic osteogenic sarcomas and very undifferentiated soft tissue sarcomas should have the benefit of this operation although the possible cures are lowest among the entire group.[6,9,13]

Ewing's sareomas, plasma eell myelomas and metastatie tumors should not be subjected to this operation execpt under unusual cireumstanees.[9,13]

SUMMARY

Sinee the first suceessful operation by Girard fifty-three years ago 132 eases have been reported. A mortality rate of 60 per eent was reported in the first seventy-nine eases. In the past eleven years operative mortality has dropped to 14 per eent. The overall mortality was 36 per eent.

This drop in mortality has been due to the development of mcthods of eombating shoek and hemorrhage. The present mortality rate ean be expected to drop still lower by a better understanding of the anatomy involved, technics developed and the institution of aetive steps to prevent shock by free use of whole blood and plasma transfusions.

Follow-up statistics have been unsatisfactory to date. However, of the forty-five patients who survived the operation and who were followed for five or more years, twenty-one remained clinically well; twenty-four died of their diseasc.

Radieal amputation seems to be a definite and distinct advancement in the radical treatment of selected cases of malignant tumors of the lower extremity, buttock, groin, innominate bone or pelvie parietes and by eareful eonsideration of these faetors in the future, prognosis of such lesions can be favorably influenced.

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TWISTED HEMATOSALPINX*

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THE term hematosalpinx was long understood to designate any tube filled with blood. Then Veit came forward with the suggestion that tubal pregnancies as well as blood tubes due to new growth should be excluded, a view which is now generally accepted. Thus hematosalpinx may be divided into the following three groups according to origin: (1) cases in which the condition is due to a congenital obstruction of the genital canal (gynatresia); (2) cases attributable to bleeding from a ruptured blood vessel into a previously occluded tube (as in salpingitis, hemorrhagic inflammation, typhoid fever or phosphorus poisoning); and (3) cases attributable to a severe disturbance in blood supply due to torsion or twisting of the tube, either normal or diseased. Heynemann is of the opinion that torsion of the normal tube is not too "uncommon" and stresses the importance of keeping this possibility in mind. In 1918 Schweitzer published a case presenting isolated torsion of a normal tube; similar cases have been described by Michael, Hansen, Scheid and Neugebauer.

The literature contains similar reports by Rueder, Aulhorn, Norris, Roger, Stark, Herff, Hirst, Barton and Branch, Neel, Lear and Virnig, Auvray, Ansbach-Prager, Eunike and others as well as reports on cases involving complete amputation of the twisted tube by such authorities as Kolb, Ruppold, Ries (bilateral), Barrett-Lash and Anderson. In 1927 before the Obstetrical Society of Vienna the writer presented a case of a twisted tube in pregnancy. Many a case of this kind is probably overlooked for the reason that diagnosis is often difficult. The writer believes, therefore, that it might be useful to describe the condition in some detail and to submit a report on a recent, particularly illuminating case.

Etiology. The literature mentions the various factors generally held responsible for torsion of a tube. As a rule, however, no clear distinction is made between the general condition, the immediate cause and the twisting forces themselves. It would seem timely, therefore, to attempt to clarify this question of the etiology of torsion and above all to establish the difference between predisposing factors and twisting forces.

The predisposing factors may be divided into two categories: (1) those directly related to pathologic conditions generally in the abdomen (e.g., adhesion, displacement of organs); and (2) those directly related to the part which is twisted.

Moreover, the twisting forces themselves can operate in two distinct ways: (1) from without (e.g., a blow on the abdomen or some extraordinary movement of the body as in sports, or dancing) with repercussions in the part in question; and (2) from within the abdomen (e.g., a growing tumor or intestinal peristalsis).

In each case the predisposing factors and twisting forces should be studied separately. The following, which lists the factors and circumstances likely to favor torsion, is designed to facilitate determination of the etiology in a given case by making it somewhat easier to recognize both the predisposing factors and the twisting forces at play.

PREDISPOSING FACTORS

1. Pathologic condition of the tube itself:
   - (A) Enlargement and elongation (Rokitansky, Anspach)
     Congenital
     Infantilism (Schweitzer)
     Acquired
     Hydrosalpinx

Hematosalpinx
Pyosalpinx
Ectopic pregnancy
(B) Abnormal mobility due to long and membranaceous mesosalpinx
Congenital (Michel, Roger, Davies, Barrett)
Acquired
Pregnancy (Aulhorn, Tauber)
Ovarian or parovarian tumor (Tauber)
2. Pathologic conditions elsewhere in the abdomen:
(A) Adhesions (Rokitansky)
due to previous operations or acute or chronic inflammations
(B) Displacement of the uterus causing narrowing of the pedicle (Barrett)
(C) Tumor formation

TWISTING FORCES

1. Extraperitoneal forces (Sellheim, Hansen, Rieder)
(A) Trauma
Fall; blow to the abdomen
(B) Active movement of the whole body
(a) Sudden or constant movements
(b) Continuous or repeatedly equal movements
(C) Increased action of the abdominal pressure
(a) by lifting heavy weights
(b) on coughing
2. Intraperitoneal forces
Traction of shrinking adhesions
Traction or pressure
of adjacent neoplasms (Tauber)
of growing pregnant uterus (Barrett, Tauber)
of displaced organs
Irregular growing of the organ itself which influences its balance (Schweitzer, Payr)
Resistance in growing to a certain direction by the presence of vessels, ligaments, etc.
Intestinal peristalsis (Schweitzer)
Tubal peristalsis
Alternate distension and evacuation of the bladder
Increasing of the abdominal pressure by straining
Hemodynamic mechanism (Payr), activated by:
Menstruation (Michel, Norris, Roger, Schweitzer)
Constipation (Stark, Schweitzer)
Coitus (Schweitzer)
Prolapsing uterus (Barrett-Lash)
Adhesion (present case)

Opinions on the twisting forces are sharply divided. Sellheim stresses the extraperitoneal forces and believes that most cases are due to these forces alone. On the other hand, Payr's interesting theory of hemodynamic torsion is completely different. After extensive studies on models and cadavers he was the first to induce intra-abdominal torsion of the pedicle of artificial tumors in the omentum of animals. He arrived at the following conclusion:

Arteries have a firm and rigid wall and act as a support for the pedicle. The veins are much longer and often tortuous. The elasticity of their walls allows an enormous increase in their capacity. Compression or kinking of the pedicle activates this development. The thin-walled veins are far more prone to obstruction than the more resistant arteries. The veins receive blood from the capillaries without resistance. In this way the veins are congested and increase in length as well as in transverse diameter and ultimately form a concave bow toward the artery. The connective tissue between the artery and the vein, however, limits the bow formation and forces the vein to form a spiral around the artery. This leads to torsion of the pedicle. Torsion brought about by unequal pressures in the blood vessels of the pedicle is termed hemodynamic torsion.

DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS

Diagnosis of a twisted tube is always a difficult matter. The clinical picture is not sufficiently characteristic; as a rule, therefore, the true nature of the condition is not discovered until the patient is being operated on, generally under the diagnosis of acute appendicitis. The twisted tube must be differentiated from ureter stone, ectopic pregnancy, acute appendicitis and salpingitis.

Both a ureter stone and a twisted tube are associated with repeated attacks of severe pain radiating to the back and to the symphysis. Urologic studies and x-ray examination will generally serve to exclude a ureter stone.

In the differentiation of a twisted tube from an ectopic pregnancy the vaginal examination is of little help. The adnexal mass cannot be outlined definitely because of the patient's inability to relax due to severe pain. The absence of fluid in the cul-de-sac of Douglas does not exclude ectopic pregnancy and the presence of fluid might be interpreted as an exudate or evaded blood from a twisted tube. Small amounts of fluid without bulging of the

posterior vaginal wall can hardly serve as a basis for the diagnosis. The red blood count is of no diagnostic value because it can be normal or subnormal in both conditions. Only the history remains; this may be very characteristic of ectopic pregnancy although in rare occasions ectopic pregnancies are encountered in the presence of normal menstruation.

Both acute appendicitis and a right twisted tube show severe pain in the right lower abdomen. The pain in appendicitis may be somewhat higher up but this finding is too vague to serve as the basis for a differential diagnosis. The difficulty is further increased by the fact that the blood count shows a high increase in the number of white blood cells and a high percentage of polymorphonuclear leukocytes in appendicitis as well as in cases of a twisted tube because of the peritoneal irritation. A history of vomiting in both conditions is another symptom likely to lead to the wrong diagnosis. The discovery of a soft, longitudinal mass on the side of the uterus, by vaginal examination after administration of a sedative or in anesthesia, will exclude appendicitis or at least suggest that appendicitis is most unlikely.

Acute salpingitis can be excluded safely by the absence of high temperature. Moreover, salpingitis is generally bilateral and commonly presents other signs of acute inflammation on the external genitalia, such as vulvovaginitis, urethritis, infection of Bartholin's glands and purulent discharge.

CASE REPORT

J. G., a twenty-eight year old woman, was admitted to the Graduate Hospital on December 23, 1946. She complained of severe pain in the right lower abdomen and was unable to walk in an upright position. She had one six year old child, with no miscarriages. Menstruation began at the age of fifteen, was regular every twenty-eight days lasting 5 to 6 days, was moderate in quantity and was associated with slight cramps on the first day. The last menstruation, which was of normal duration and quantity, was on December 9, 1946. The patient had undergone a left salpingo-oophor-

ectomy, February 17, 1942, because of an ectopic pregnancy.

For the past two years the patient complained of pain in the right side of the abdomen and the back all the way down to the inguinal region. The pain came in attacks, the first of which made its appearance two years previously. An x-ray examination was done in another hospital where she was informed that she had a ureter stone. She said that the stone dissolved after she took medicine. For the past year she was treated every month by dilatation of the ureter. There was a second major attack on Easter, 1946. Again she was hospitalized and treated by ureter dilatation. In November, 1946, a third attack brought her back to the same hospital where x-ray studies and dilatation of the ureter were carried out. The patient was in permanent pain ever since and was unable to walk or stand upright. On December 17, 1946, a fourth attack led to hospitalization. X-ray studies and urologic examination were completely negative. The patient was discharged from the hospital but was never free of dull pain in the abdomen. On December 22, 1946, she suffered an attack of severe pain accompanied by vomiting. Her family physician sent her to the Graduate Hospital.

On admission the patient's temperature was 100.1°F. and her pulse, 92. The right lower abdomen was so extremely tender that she could not tolerate the slightest touch. After administration of a sedative a careful vaginal examination was performed. The following findings were noted: uterus of normal size, in body axis, firm and of limited mobility; the right adnexal area was extremely tender; a soft mass between the right uterine edge and the symphysis could be palpated but it was impossible to outline the mass definitely because of the pain and the patient's resistance.

The chart of the previous operation bore the information that a left salpingo-oophorectomy had been done because of an ectopic pregnancy, the latter having been determined by the microscopic finding of large cells and syncytial masses in the fallopian tube.

No diagnosis could be given after the first examination after admission. Ectopic pregnancy on the right side, a ureter stone, appendicitis and acute salpingitis were under discussion. The family physician informed us that a urologic examination, including an x-ray study performed a few days previously in another
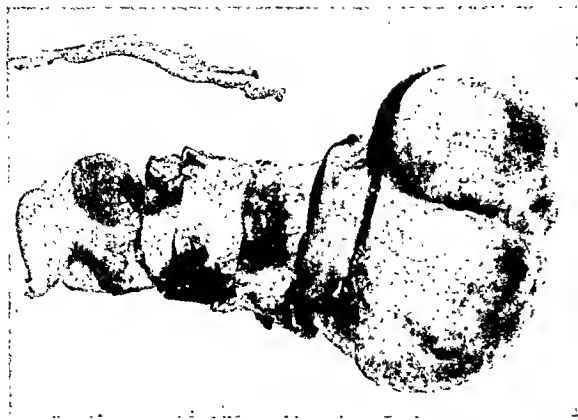
Fig. 1. Specimen of the removed right hemato-salpinx and the band-like adhesion which extended across the pelvis. After fixation the specimen was cut in several segments to allow histologic studies in order to exclude inflammation and ectopic pregnancy.

hospital, had been completely negative. On the strength of this information the diagnosis of a ureter stone was excluded. Ectopic pregnancy seemed most unlikely in view of the history of perfectly normal menstruation. The temperature of 100.1°F. did not suggest an acute process in the appendix or the adnexal area.

The blood count revealed the following: erythrocytes, 4,400,000; hemoglobin, 75 per cent (12.5 Gm.); leukocytes, 13,900; neutrophiles, 88 per cent; lymphocytes, 10 per cent; and mononuclears, 2 per cent. The blood count pointed to acute appendicitis but the vaginal findings suggested an adnexal disease. The fact that the temperature was only slightly elevated together with the comparatively low pulse certainly seemed to exclude any acute inflammation. Therefore, while no definite diagnosis had been made, we decided to resort to surgery in the expectation of finding some pathologic condition in the adnexal area.

The abdomen was opened by midline incision. On the right side there was a bluish-black adnexal mass the size of a lemon which proved to be the enlarged right tube. The mass was caught by a band-shaped adhesion some 7 em. in length which extended across the inlet of the pelvis from the top of the bladder to the sigmoid and which probably had been caused by the previous operation. The tubal mass was twisted, making four times a complete turn of 360 degrees. The ovary was abnormally far from the tube. There was no free blood in the abdominal cavity. Salpingectomy was performed and the band-shaped adhesion was removed. The cecum was inspected but no appendix could be detected. The appendix probably had been removed in the course of the first operation but no mention of the fact appeared on the chart.

The postoperative course was uneventful and the patient left the hospital on the tenth day after surgery. She had no complaints and said she felt perfectly well.

Pathologically, the fallopian tube was a bluish-black, retort-shaped, twisted mass showing acute circulatory changes. (Fig. 1.) The length of the tube was 10 em. and its greatest diameter was 4.5 em. The peritoneal surface was smooth and the mass was semi-solid. The uterine end was conical and the two loops formed by the torsion were glued together. The fimbriotic end was closed. Only a few small residua of the fimbriae were present. Section of the tube revealed a thick, dark red wall. The lumen was filled with clotted blood and bloody fluid; longitudinal folds were visible after removal of the contents.

Histologically, the muscle fibers of the tubal wall were separated by masses of red blood cells and by edema. The vessels were markedly dilated. There was extensive thrombosis of the veins. The endosalpinx was infiltrated with blood; the epithelium was flattened and lifted away from the underlying layers in some areas. At a few points there was no trace of epithelial tissue. The wall contained many cells filled with blood pigment. No evidence of inflammation and ectopic pregnancy could be found.

The pathologic disturbance in this patient was an originally normal right tube which had undergone acute axial torsion resulting in strangulation with consequent hemorrhagic changes. The rapid development of the edema together with the thrombosis of the veins gave the pedicle a plastic consistency which made detorsion and restitution impossible.

COMMENTS

This case is especially illuminating from the diagnostic viewpoint. Even a previous appendectomy did not prevent the usual error of taking appendicitis into serious consideration. The patient did not know that the appendix was out and, as mentioned, the appendectomy was not recorded on the old chart. The possibility of a ureter stone could be excluded here in view of the

complete urologic examination performed in another hospital only a few days before admission. However, it is amazing to note that this patient was treated repeatedly in the same hospital for a stricture of the right ureter and for a ureter stone two years previously. She had never seen the stone nor had its presence ever been demonstrated by x-ray. It is highly probable, therefore, that the various attacks which led to the repeated hospital visits were due to torsion of the tube and that the attacks of pain were due to the pathological condition of the tube rather than to some dubious ureter stone. This, however, can be considered proved beyond doubt only if the attacks do not recur in the future.

Ectopic pregnancy was not definitely excluded but seemed most unlikely in view of the history of perfectly normal menstruation. The patient reported no irregularity; both the duration and the amount were normal and constant as far as could be ascertained. However, the history of a previous ectopic pregnancy on the left side did arouse the suspicion that the case might possibly be one of ectopic pregnancy on the right side.

The difficulties involved in making the diagnosis of a twisted tube underscore the importance of considering the possibility of acute salpingitis as well as of a twisted tube in any case of questionable appendicitis in a female patient. Attacks of pain always point to the diagnosis of twisted pedicle. This symptom, which is generally recognized as pathognomonic in ovarian cysts, is often neglected in the diagnosis of a twisted tube so long as there is no ovarian pathology. However, the history of repeated attacks of pain seems to be more significant diagnostically than all the other symptoms and constant awareness of this fact will prevent many errors and enhance the chances of a correct diagnosis of twisted tube before the abdomen is opened.

As for the etiology of the case under discussion, inspection of the tables will show that there were predisposing factors here directly related to pathologic conditions in

the tube itself as well as elsewhere in the abdomen. There was a firm adhesion across the pelvis due to the previous operation. The ovary was abnormally far from the tube, showing that the right mesosalpinx was extremely long, forming a pedicle which was well predisposed for torsion. The tube itself was abnormally long, probably a congenital condition. It seems very likely that there was also an elongation of the other tube and that this brought on the ectopic pregnancy which was operated upon two years ago.

The patient gave no history of trauma. There was no recollection of any fall or blow to the abdomen which could be construed as an extraperitoneal twisting force but, of course, active and extraordinary movements of the whole body and increased abdominal pressure can never be excluded completely.

In this case the intraperitoneal forces and, most particularly, the factor of tubal peristalsis seem to be of greater importance. It requires no stretch of the imagination to picture the probable sequence of events here. Since the long tube on the elongated mesosalpinx had an exceptionally wide range, the tube was caught in the band-shaped adhesion across the pelvis; the band exerted pressure on the tube, blocking the circulation and thus activating the twisting forces for hemodynamic torsion. Torsion, in turn, brought on the pathologic changes. It may be presumed that these changes took the following course: the peritoneal layers of the tube were glued together; congestion increased more and more; the mucous membrane became edematous; and blood evaded into the lumen; the fimbriatic end was inverted as a result of the extremely swollen condition of the mucosa (a mechanism described by Opitz); the tube, finally, closed up and the collection of blood in the tube formed the hematosalpinx. In this case, therefore, it would seem that a previously normal tube had been twisted and that the hematosalpinx subsequently developed. The hematosalpinx became another predisposing

factor favoring the subsequent torsions. The twisting forces of the later torsions were probably a combination of the hemodynamic mechanism and extra- and other intraperitoneal forces.

SUMMARY

A brief review of selected cases of twisted tube was followed by a few words concerning the significance of this condition. An attempt was made to dispel some of the confusion surrounding the etiologic problems by drawing a sharp distinction between the predisposing factors and the twisting forces. Tables listing such factors and forces were submitted in the hope that this condensed information might facilitate determination of the etiology in a given case. The difficulties involved in making the diagnosis were pointed out and some directions were given as to the manner of differentiating between this condition and other entities presenting similar symptoms. An enlightening case observed by the writer was reported in detail notably for the purpose of illustrating the difficulty in establishing the differential diagnosis. The pathology and the development of the pathologic changes in the normal tube were discussed.

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PLANTAR FIXATION SIGN

DIAGNOSTIC AID IN ACUTE ARTERIAL INTERRUPTION OF THE LOWER EXTREMITY

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THE purpose of this communication is to describe a physical sign which, when applied to acute interruptions of the main artery of the lower extremity, may prove useful in differentiating these lesions from other conditions which at times closely simulate them. Cases quoted herewith represent trauma seen in a theatre of war but there are reasons to believe that similar interruptions in civil practice could also be attended by the same sign, making this diagnostic addition no less useful in the latter type of practice.

Having been assigned to the attendance of vascular injuries in an evacuation hospital, it was soon observed that complete interruption of the main stem artery of the lower extremity produced in as little as *five hours* a degree of muscular (fibril) swelling which, although not appreciably increasing the diameter of the affected calf, so interfered with the passive stretching of the muscles as to render the foot incapable of dorsiflexion beyond a right angle. When unsuspected or unproved interruption of the main stem artery was present and the patient was in such a state of shock that there was no pulse in either foot, or when a moderately shocked patient had been exposed to cold so that both extremities were of nearly equal temperature, the sign then became useful as an added indication of a condition frequently undiagnosed in forward stations (and occasionally in the shock ward of this field type hospital) before the patient had been resuscitated sufficiently from shock to restore pulse, color and differentiation of temperature when comparing the two extremities or, obviously, before gangrene was clinically evident.

The performance of this test is essentially the same as that producing Homan's sign but is an objective test and does not depend on patient participation, namely, complaint of pain. Furthermore, in the type of patients referred to in this communication pain was frequently due to accompanying injuries in other portions of the extremity (or the same portion, in fact) and derived from the motion of fractures multiple soft tissue injuries and so forth.

A limitation of passive dorsiflexion of the foot, except for such obvious reasons as fracture in the region of the ankle, was never observed in these badly injured extremities except when vascular interruption was later demonstrated. Also, the sensation of a markedly edematous muscle which has reached its maximum passive extension is quite different from that of a spastic muscle which still retains good tone. The sensation is similar to that which would be expected if the lever (foot) were attached to a rope, or nearly so, depending on the stage of advancement of the effects secondary to complete ischemia. (Fig. 1.)

The cases reported herein were selected to illustrate this sign.

CASE REPORTS

CASE I. L. H., an infantry private, twenty-four years of age, was admitted with a perforating wound of the left thigh, femoral triangle region. When first seen he had no pulse in either foot and his blood pressure was 80/40. He had had 1 unit, 250 cc. of plasma in a forward station. On admission his feet were approximately of equal temperature, namely, warm but the left foot could not be dorsiflexed beyond a 90 degree angle, whereas the right could be and the sensations at the limits of dorsiflexion were different on the two

sides as heretofore described. The patient was given 2 units of blood and when he was in a condition more appropriate for operation, it was demonstrated that the femoral artery had been completely transected and closed by thrombus near the middle of the femoral

the patient did not react from anesthesia for six hours. Because of the poor response to the laparotomy, nothing was done for the other injuries at the first stage.

Immediately on reaction from anesthesia the patient complained of pain in the left leg.
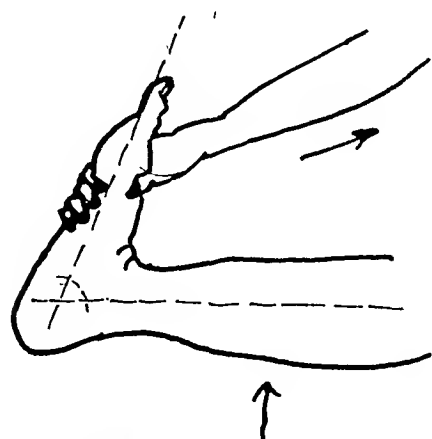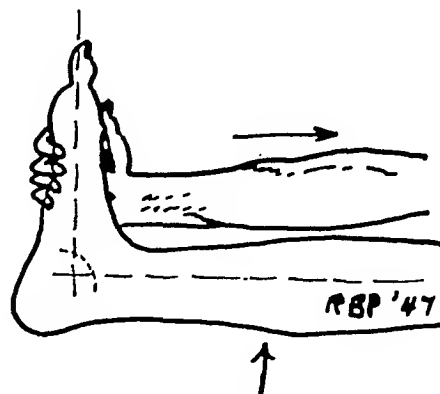
NORMAL ELASTICITY IA   CHARACTERISTIC RESISTANCE IB

FIG. 1. A, normal flexes 75 (±5)°; B, plantar fixation +90° or more.

triangle and that the profunda artery was intact but so spastic as to have a negligible pulsation. The wound was débrided, the femoral artery and vein were ligated and periarterial stripping up to the inguinal ligament was performed. By the sixth postoperative day the patient had demarcating gangrene up to the ankle.

CASE II. G. G., a twenty-one year old staff sergeant, was admitted with a history of having sustained multiple shell fragment injuries of the abdomen, both lower extremities and face. On surveying the patient the most outstanding signs were those of peritonitis but it was noted that there was no pulse in either foot and this was ascribed to shock which the patient undoubtedly had. Having no peripheral blood pressure, notwithstanding 1 L. of plasma before admission and 1 soon after, the patient was given 2 L. of whole blood following which he attained a blood pressure of 120/60.

As soon as the condition warranted and under bilateral field block of the abdomen a laparotomy was performed and four perforations of the jejunum were sutured, the subdiaphragmatic spaces irrigated and 4 Gm. of powdered sulfadiazine deposited therein before a layer closure, necessarily implemented by additional ether anesthesia. His postoperative condition was poor, blood pressure 90/40 and

At this time it was observed that the left foot was cooler than the right and the left foot could not be dorsiflexed even to 90 degrees, whereas the right, which showed equally as many penetrating and perforating wounds, could be so flexed. The patient had been given supportive treatment during the interval, including 2 L. more of blood. He was returned to the operating room and the left leg was opened liberally (fascia); the wounds in the upper part of the calf were débrided. During this process the posterior tibial artery was revealed completely transected very near its origin and thrombus had propagated proximally and partly involved the peroneal artery. Postoperatively there was a weak pulsation of the dorsalis pedis artery and repeated lumbar sympathetic blocks with 1 per cent procaine were done in an attempt to save the extremity. However, slowly progressing gangrene of the foot during the subsequent eight days eventually required mid-calf amputation.

CASE III. D. C. P., a captain, aged thirty-two, was admitted to the hospital with a history of having been struck in the left shoulder and right knee by "burp gun" slugs (.25 caliber, low velocity lead balls) twenty-four hours prior to admission. Examination showed severe shock, pulseless right foot and the plantar fixation sign positive. The patient

also had small wounds of the left shoulder, posterior chest, wounds above and below the right knee medially and laterally and a fracture of the left sixth rib but there was no evidence of intrathoracic injury. The patient was given general supportive measures, including 2,500 cc. of whole blood, and required several hours before he was considered suitable for operation. Examination of the right popliteal space under tourniquet showed a complete interruption of the popliteal artery and vein. The first part of the axillary artery was exposed for purpose of preventative hemostasis and a tape was passed beneath the vessel. Exposure of the third part of the axillary then showed a complete interruption of that vessel just distal to the origin of the subscapular artery. The axillary was also ligated, the several chest wounds were débrided and lumbar sympathetic block was done with procaine. The patient relapsed into shock with this latter procedure, his blood pressure falling to 65/50; but he responded to steep Trendelenburg position and an additional 1,000 cc. of whole blood. The upper extremity was asymptomatic and useful on the seventh postoperative day; it blanched on elevation only. The lower extremity gradually became gangrenous.

CASE IV. W. F. S., a sergeant, aged twenty-seven, was admitted with a history of injury by multiple fragments of a mortar shell which burst at close range; duration of injury, sixteen hours. Examination showed marked shock and absence of pulsation in both feet although a blood pressure of 80/50 was obtained. The dorsiflexion sign was positive for the left foot and in addition there was apparent distention of the deep fascia of the calf on this side. As the shock was treated, the tension of the deep fascia increased and the foot was drawn spontaneously into plantar flexion from which it could not be elevated. The explanation for this unusual degree of swelling was brought out at operation. Extensive débridement of the lateral walls of the popliteal fossa (collaterals) was required in addition to ligation of the popliteal artery and vein. This extremity rapidly became gangrenous because of multiple injuries, several of which involved bone and because of severe infection superimposed upon the ischemia.

The following cases illustrate the utility of the sign in a negative sense. These cases

in which the location of the injury and the peripheral signs strongly suggested main stem arterial occlusion but which did *not* demonstrate a plantar fixation sign were proved by operation to be severe vascular spasms arising from reflex stimulation.

CASE V. J. F. L., an infantry private, aged twenty-seven, was admitted to the hospital with a perforating wound of the right thigh which had been caused by a large shell fragment twelve hours prior to admission. Immediately overlying the femoral artery in the lower portion of the femoral triangle was a large, ragged wound of entrance (3 cm. in diameter) and there was marked deep distention of the thigh, suggesting tension typical of interruption of a large vessel. In addition to these signs the foot was cool in contrast to the unaffected side and careful examination enlisted no pulse in the popliteal or smaller distal arteries. The dorsiflexion sign was negative. In view of the other signs, however, the patient was prepared as if for operation of an artery, including a large cannula in an arm vein and whole blood available in quantity. The patient was anesthetized and a heavy tourniquet was applied through the groin, utilizing Kirschner wires after the manner of the Wyeth pin. Complete dissection of the thigh showed numerous muscle arterial interruptions but examination of the femoral, profunda and even obturator arteries showed no damage to these vessels. The tourniquet was removed, the wound was débrided and hemostasis attended. There was weak pulsation in the femoral (very spastic) but still no pulsation in the peripheral arteries.

This patient was treated as if he had had major arterial interruption (with such facilities as were available) including repeated lumbar sympathetic blocks, whiskey, interdiction of tobacco, level leg and continuous oxygen for the first three days. After twenty-four hours weak pulses returned to a normal-looking foot and on the fifth day, oscillometric readings were only slightly reduced on the affected side as compared with the well leg.

CASE VI. M. L. H., an infantry private, aged 19, was admitted to the hospital with a history of having been shot through both legs by a sniper twelve hours prior to admission. Examination showed the patient in moderate shock and with a most unusual injury in that a

single missile had entered the lateral aspect of the right popliteal fossa, traversed it and exited on the medial aspect. It then entered the left popliteal fossa at almost the identical level and exited this space, creating four small puncture wounds (two of entry and two of exit) and a moderate hematoma beneath the deep fascia in each situation. Both feet were cold and pulseless but the sign of plantar fixation was present on the right only.

After appropriate measures restoring the patient to an operable state the left popliteal fossa was investigated first and, as in a previous case, it was necessary to ligate only large muscle branches including the sural arteries. On the right, however, the popliteal had been transected in the upper part of its course and considerably more damage was done to other soft parts including the popliteal vein, the tibial nerve and the origins of both heads of the gastrocnemius muscle.

The patient's temperature soon rose to 103°F. and there was no difficulty deciding to which extremity to ascribe the cause of this elevation as the right foot and leg became gangrenous, whereas the left promptly recovered its vascular balance.

CONCLUSION

A new diagnostic sign with which one is apparently capable of differentiating acute arterial interruption in the lower extremity from vascular spasm is offered. Cases are cited, both positive and negative, to demonstrate the utility of this sign.

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ACCORDING to E. I. Lowenberg, if emboli in the large arteries are removed within the first ten hours, amputation may be avoided. Paravertebral novocain block of the related sympathetics and intravenous injections of papaverine hydrochloride (½ gr.) help to overcome the associated vasospasm. Anticoagulant therapy also plays an important part and must be continued after embolectomy to prevent the postoperative occurrence of secondary thrombosis. Postoperative sympathetic block also must be continued for the same reason. Instead of using local novocain injections, a similar effect can be produced by intravenous or intramuscular injections of tetraethylammonium bromide. Medical regimen alone may be indicated when only a smaller artery is involved or when the embolus has been present for over ten hours. Refrigeration anesthesia can be used if amputation becomes inevitable. (*Richard A. Leonardo, M.D.*)

New Instrument

A NEW SELF-RETAINING RETRACTOR*

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New York, New York

OUR purpose in designing this retractor was to construct an instrument which would meet the needs of both abdominal and genitourinary surgeons.

The retractor has three removable retracting blades which are adjustable so that the one instrument can be used for (1) open operations on the urinary bladder, (2) exposure of the prevesical structures, (3) operations on the lower ureter and (4) other abdominal procedures which require deep retraction. The difficulty encountered in retracting the wound edges in obese patients is overcome to a great extent by a simple screw adjustment of the lateral blades; this can extend the depth of the blades up to an added ¾ inch. Figures 1 and 2 show the architecture of the instrument as viewed from above (surgeon's eye view) and laterally.

The retractor is sturdily built along the simplest lines and uses the most suitable angles for greater retraction. Its three blades are adjustable, reversible and removable so as to give the instrument the maximum versatility and thereby make it a useful device for as many types of abdominal operations as possible rather than for one particular procedure. The surgeon needs only one retractor boiled for operation and still will be able to cope with any surgical eventuality that may present itself. The necessity of boiling several retractors is thereby eliminated.

The lateral blades of the retractor are not only adjustable for depth but are also reversible so that their convex or concave surfaces can be made to curve inward or outward to meet the needs of the surgeon. Figure 3 shows the versatility of the lateral blades in operations involving the urinary bladder in which it has usually been necessary to enlist the aid of an extra assistant for purposes of retracting the bladder walls. In the drawing, the blades are set so that their concave surfaces present into the bladder. This position of the blades allows a larger operative field. The bladder walls remain in the desired position and it is not necessary to place a fixing suture from the edge of the bladder to the rectus fascia. After the incision in the bladder has been made, the cut edges of the wall are grasped with Allis clamps and held apart to permit entrance of the lateral blades. The retractor is then held at an angle so that only one blade at a time is inserted into the bladder lumen. After entry of the first blade the hand screw is tightened to keep the blade in position; the retractor is then leveled off and the untightened remaining lateral blade is inserted into the bladder and the screw set. The retractor is then ready for use.

In retropubic prostatectomy, in which exposure of the anterior surface of the prostatic capsule with its adjacent vessels and a good, unimpaired view of the prostatovesical junction are imperative, the retractor is especially useful. Figures 4 and 5 show the instrument in the proper position for such an operation; here the lateral blades are shown adjusted so that their convex surfaces present in the wound. They are also set for maximum depth.

Figure 4 clearly shows the need for deep

Screw with knob to control depth of lateral blade of retractor

Lateral blades

Middle blade of retractor

Screw to control angle or depth of middle blade of retractor

Screw to control horizontal excursion of middle blade of retractor

Screw to control lateral excursion of middle blade of retractor

Screw to control excursion of lateral blade
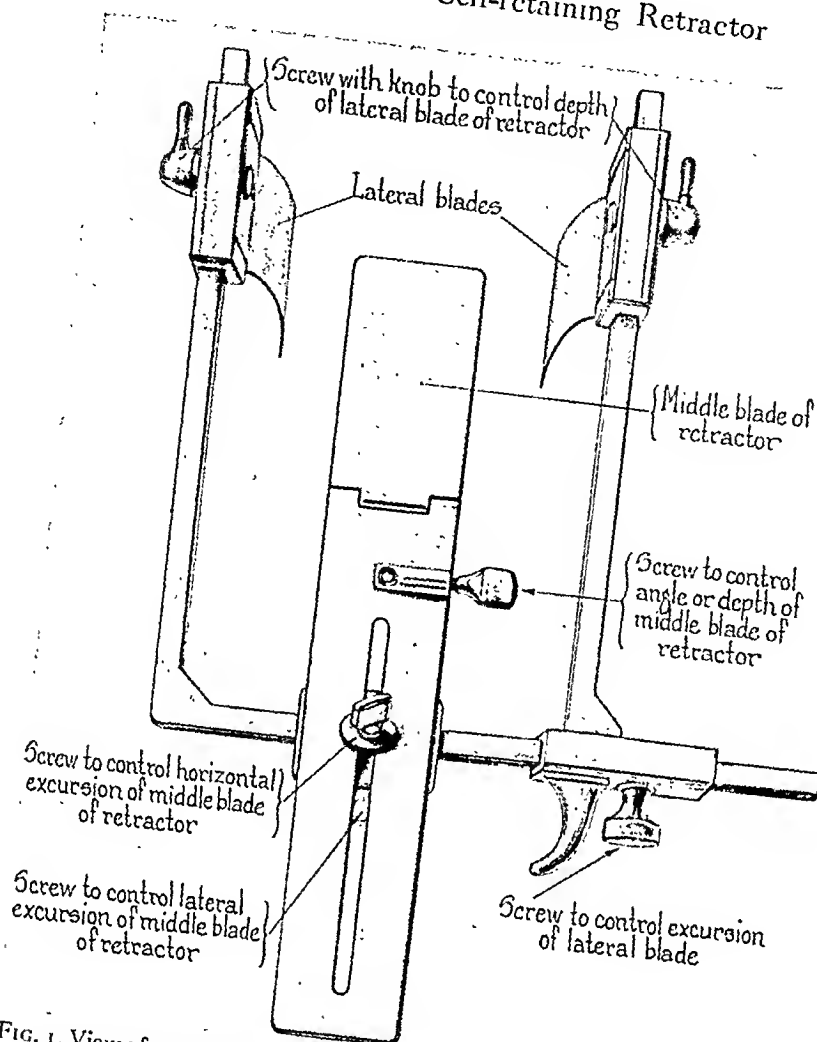
FIG. 1. View of retractor from above showing framework and blades in position. The lateral blades are reversible, concave or convex and adjustable for depth.

and constant retraction in retropubic surgery. This drawing beautifully illustrates the position of the lateral blades and their relation to the lateral plexus of veins. The tips of the blades are in the lateral prostato-vesical recesses, thereby exposing as much as possible of the anterior and upper lateral surfaces of the prostatic capsule and the plexus. A transverse incision has been made in the anterior capsule down to the adenoma. The relation of the prostato-vesical junction to the incision is clearly outlined. For the sake of clarity the three preliminary hemostatic and retention sutures generally placed in the anterior prostatic capsule prior to incision of the capsule have purposely been omitted in the drawing. Access to the lateral recesses of the bladder is easily obtained after careful hand and stick-sponge retraction of the retropubic fat. Beneventi and Twinem* have stressed the importance of exercising care in this dissection so as not to open the large plexus of veins which hugs the lateral walls of the prostate and bladder. Gauze sponges may or may not be used as traps for spilled blood in the lateral recesses, depending on the surgeon's preference. The blades of the retractor are rounded, smooth and blunt; and the bare blades have never, in our experience, been known to damage any of the neighboring structures.

In performing suprapubic or retropubic

* BENEVENTI, F. A. and TWINEM, F. P. Experiences with retropubic prostatectomy. *New York State J. Med.,* 49: 623–628, 1949.

Screw to control depth of lateral blade of retractor

Screw to control angle or depth of middle blade of retractor

Screw to control excursion of lateral blade

Screw to control horizontal excursion of middle blade of retractor

Screw to control lateral excursion of middle blade

Middle blade of retractor

Lateral blade of retractor
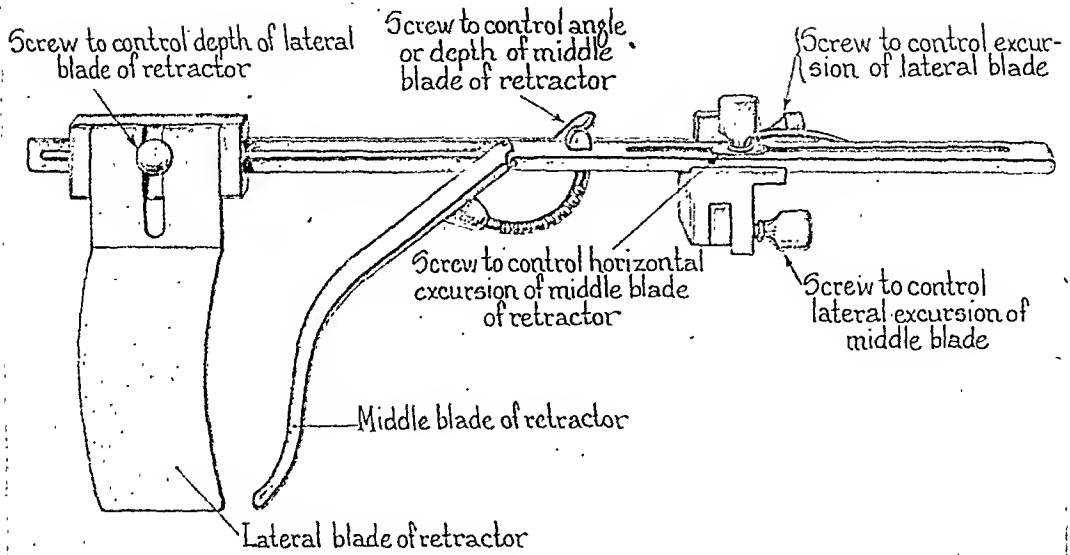
FIG. 2. Lateral view of retractor.

Screw with knob to control depth of lateral blade of retractor

Bladder opened

Tumor in bladder

Middle blade of retractor in bladder

Screw to control angle or depth of middle blade of retractor

Screw to control horizontal excursion of middle blade of retractor

Screw to control lateral excursion of middle blade of retractor

Trigone and orifice of right ureter

Removing tumor with loop electrode

Screw to control excursion of lateral blade of retractor

FIG. 3. Retractor in position for exposure of bladder tumor, with tumor being removed with loop electrode. Lateral blades are adjusted so that their concave surfaces are present in the wound. Medium arm is adjusted for anterior retraction.
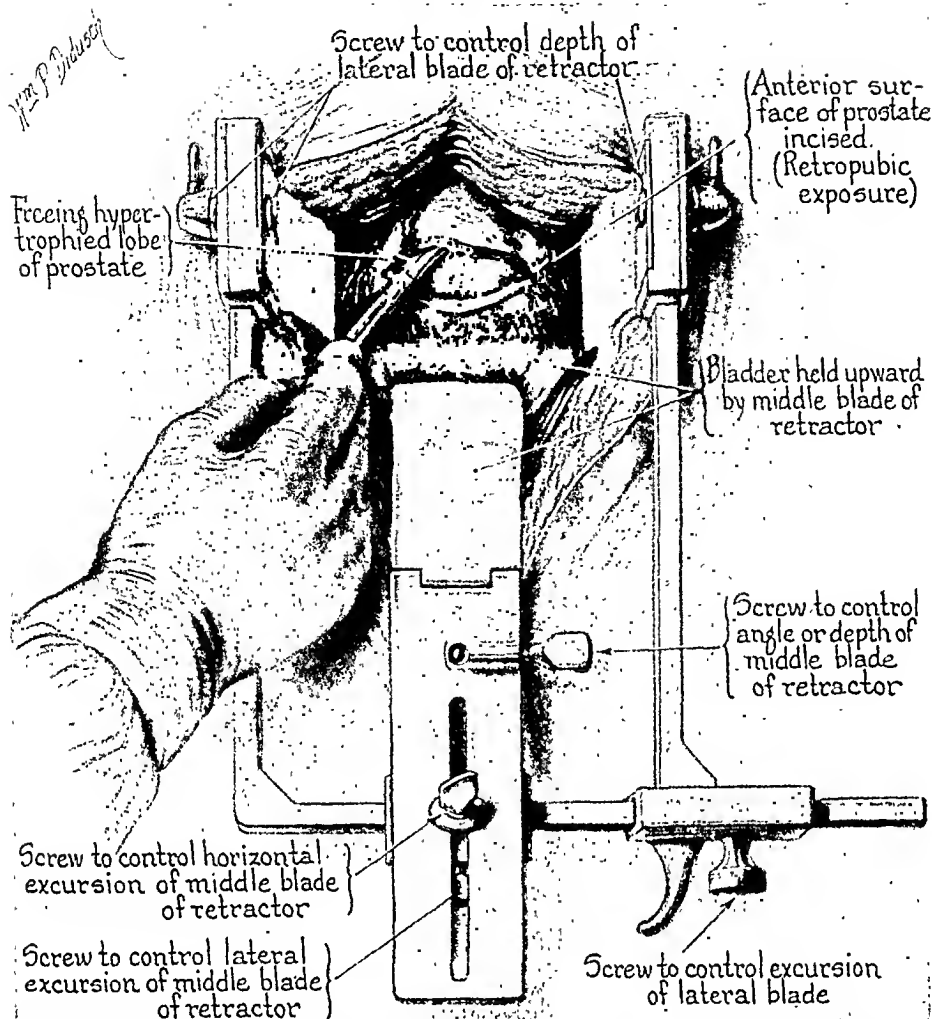
FIG. 4. Retractor in position for retropubic prostatectomy. Lateral blades are adjusted in this case so that their convex surfaces are present in the wound. Middle blade retracts and depresses fundus of bladder.

surgery, the cross piece of the retractor should lie at the upper angle of the wound and the lateral blades should be placed at the most distal part of the lateral arms. (Figs. 3, 4 and 5.) After the lateral retractors have been placed in position in the wound the middle blade is simply snapped on the cross piece, adjusted to the desired position and securely fastened with the hand screw. This blade depresses the anterior bladder wall and retracts the peritoneum and fat upward. Figure 5, showing a sectional view in retropubic prostatectomy, demonstrates graphically the double action of this part of the instrument. The hinge-joint action is extremely gentle on the retracted tissue, yet it is firm and can

be securely set in any position by the aid of two hand screws. Unlike the lateral blades the middle blade snaps on the cross piece so that it can be set in place or removed without disturbing the position of the retractor in the wound.

The retractor has been used in abdominal operations other than those dealing with the genitourinary tract, with a great deal of success and satisfaction. Many suggestions have been received from general surgeons regarding wider blades for use in gastric surgery, thinner blades for small incisions and deeper blades for use in the very obese. These are now being constructed and will be used as interchangeable parts.

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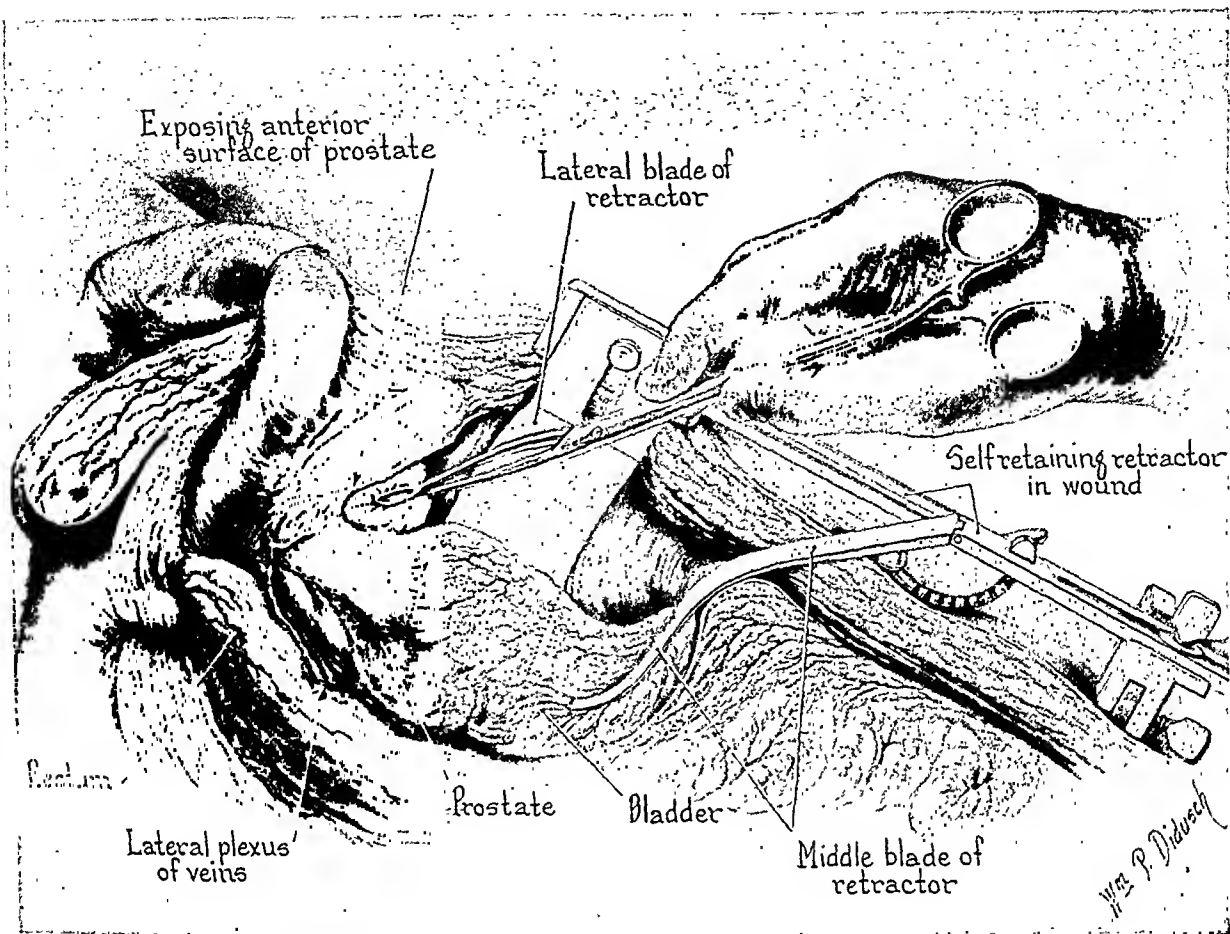
FIG. 5. Retractor in position for retropubic prostatectomy; sectional view.

The frame of the retractor is best described as an open-end square with each arm 8 inches long. At present, the retracting blades are 1½ inches wide and made to curve for maximum versatility and exposure. The instrument is soundly constructed and has sufficient weight to keep it from popping out of the wound during operation. It is designed to withstand the strong pressures exerted on the wound margins in obtaining surgical exposure in deep abdominal wounds, without disturbing the position of the retractor.

COLUMBIA UNIVERSITY
COLLEGE OF PHYSICIANS AND SURGEONS

New York

FOUNDED in 1754 by a royal grant of George II, King of England, "for the instruction of Youth in the Learned Languages, and the Liberal Arts and Sciences," Columbia College began as King's College. Its program was interrupted by the Revolutionary War, but in 1784 it was re-opened as Columbia College. In 1912 the title was changed to Columbia University in the City of New York.

A medical faculty was organized at King's College in 1767. It was the first institution in the North American Colonies to confer the degree of Doctor of Medicine in course. The first individuals to graduate in medicine from the College were Robert Tucker and Samuel Kissam, who received the degree of Bachelor of Medicine in May, 1769, and that of Doctor of Medicine in May, 1770 and May, 1771, respectively. Instruction in medicine was continued until the War of the Revolution. In 1784 an act was passed making Columbia College in the City of New York the successor of King's College, and instruction was resumed in the academic department. The medical faculty was reestablished eight years later. In 1814 the medical faculty of Columbia College was merged with the College of Physicians and Surgeons which had obtained an independent charter in 1807. By agreement between the trustees of the two institutions in 1860 the College of Physicians and Surgeons became the medical department of Columbia College. From that time on the diplomas of the graduates were signed by the President of Columbia College as well as by the President of the College of Physicians and Surgeons. The connection was only a nominal one, however, until 1891 when the College was incorporated as an integral part of the University.

In 1945 the Medical Faculty was made responsible for the educational program in Medicine, Dental and Oral Surgery, Public Health and Nursing, and Associate Deans were named to each of these divisions.

In medicine the minimum requirement for admission to the first year class is attendance for three full academic years at an approved college of arts and sciences. Preference is given in the selection of students to those who, in the opinion of the Committee on Admissions, present evidence of high achievement in their college education and who are most likely to succeed in medicine, rather than to those who present the largest number of course credits or who have limited their preparation largely to the premedical sciences. Of the one hundred fourteen students who entered the medical school in 1947 seventy-two were discharged veterans. Since September, 1917, women have been admitted to the school on the same basis as men.

The School of Public Health is part of the Medical Faculty of Columbia University and shares in the research and teaching resources of the Columbia-Presbyterian Medical Center and of the affiliated hospitals and clinics.

The School of Tropical Medicine of the University of Puerto Rico, under the auspices of Columbia University, is maintained in part by the government of Puerto Rico and in part by Columbia University. The latter directs the educational policy and nominates the teaching and research staff, subject to the approval of the Special Board of Trustees. The courses at the Columbia University School of Public Health are so arranged that a student in public health or tropical medicine may for the first two quarters absolve
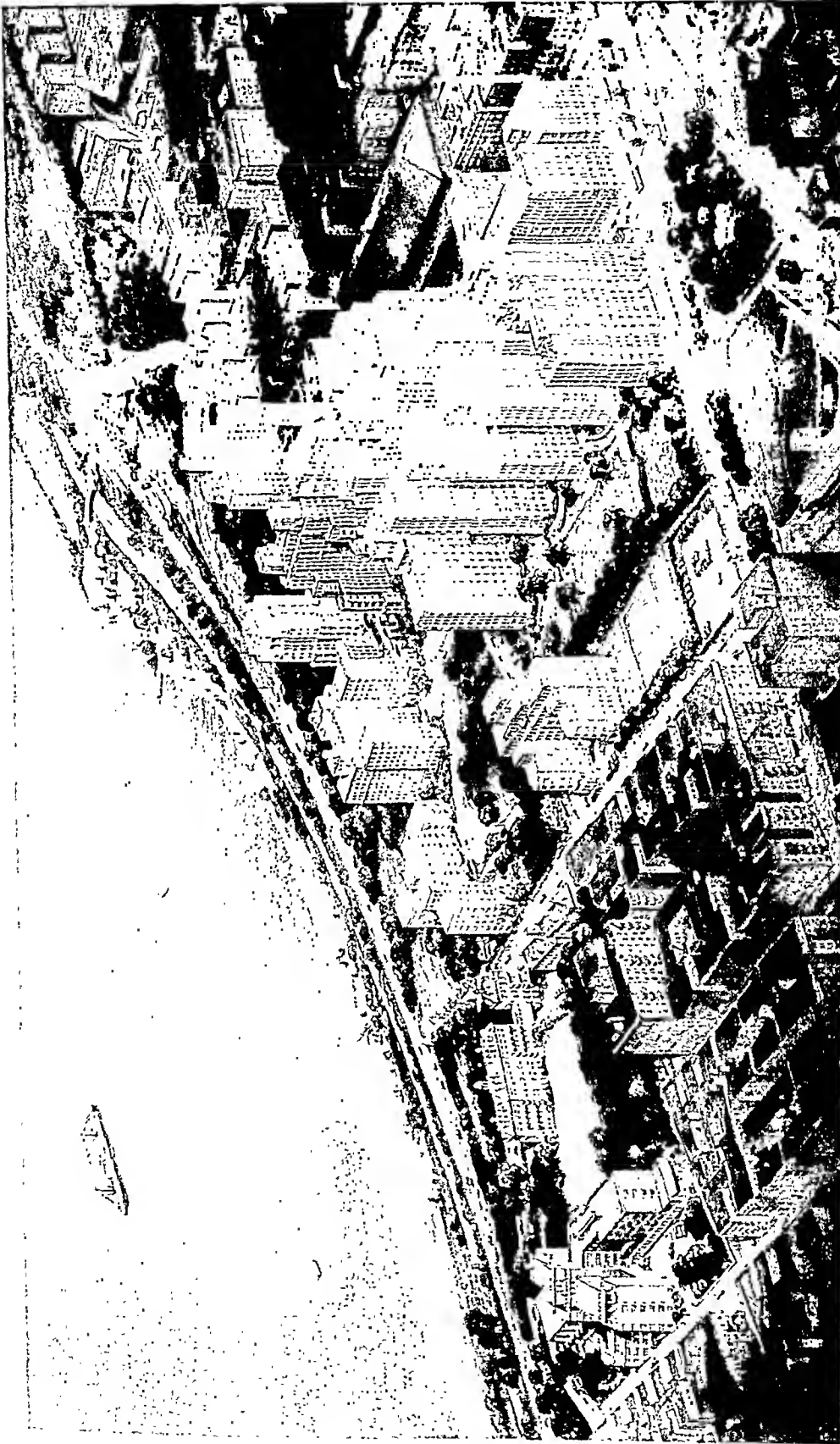
Columbia University College of Physicians and Surgeons

the school's requirements as to basic courses and in the third and fourth quarters pursue elective studies in a tropical environment at the Puerto Rico School of Tropical Medicine. In the Virgin Islands the school maintains clinical and research studies. The Faculty of Medicine offers a program of study leading to a Bachelor of Science degree in Physical Therapy and in Occupational Therapy.

In January, 1944, all the voluntary hospitals and clinics at the Medical Center were consolidated into a single corporation under the Presbyterian Hospital. The several hospitals continue to function as separate units of the Presbyterian Hospital. The Medical Center group is as follows: The College of Physicians and Surgeons, School of Dental and Oral Surgery, School of Nursing, School of Public Health, Washington Heights Health and Teaching Center, New York State Psychiatric Institute; the Presbyterian Hospital and its subdivisions: the Squier Urological Clinic, the Institute of Ophthalmology, Harkness Pavilion, Sloane Hospital for Women, Vanderbilt Clinic, Babies Hospital, Neurol-ogical Institute, the New York Orthopedic Dispensary and Hospital and the Mary Harkness Convalescent Home.

Other hospitals used for teaching purposes are Bellevue Hospital, Goldwater Memorial Hospital, Hospital for Joint Diseases, Hospital for Special Surgery, Institute for the Crippled and Disabled, Margaret Hague Maternity Hospital (a unit of the Jersey City Medical Center), Mary Imogene Bassett Hospital, Cooperstown, N. Y., Montefiore Hospital for Chronic Diseases, Morrisania Hospital, Mount Sinai Hospital, Roosevelt Hospital, St. Luke's Hospital, Willard Parker Hospital and Woman's Hospital.

Bard Hall, the residence for students of the Medical School, is located on the property of the Medical Center. It is a building of eleven stories with three additional stories in the north wing and it occupies a site overlooking Riverside Drive and the Hudson River. There are rooms to accommodate women students. All medical students enjoy the privileges and facilities of the University campus.

Editorials

TRANSPLEURAL BILATERAL VAGOTOMY WITH VAGUS RESECTION FOR PEPTIC ULCER*

THE ultimate goal of internists and surgeons alike seems to have been reached by the sectioning of both tenth cranial nerves either above or below the diaphragm, particularly for intractable, non-obstructing duodenal ulcers.

The ideal candidate for this operation is the chronic dyspeptic who has suffered for many years with a non-obstructing duodenal ulcer without responding favorably to adequate medical treatment, such as mental and physical rest, diet and medication. This type of patient has the well known history of persistent ulcer pain and gastric distress with vomiting and resultant loss of weight, sleep, appetite and strength. The individual often paces the floor during the night because of recurrent pain and discomfort; he or she cannot earn a living or enjoy life. In fact, many such patients contemplate suicide.

Approximately seventy patients with acute, perforated peptic ulcers are admitted to our wards yearly. These ulcers should be closed promptly by the surgeon.

One of my patients, who had a non-obstructing duodenal ulcer, had a perforated duodenal ulcer some years earlier. He was a candidate for vagotomy. While he was being worked up for a tenth nerve section in this hospital, his ulcer perforated a second time before I was ready to do a vagotomy. The Mayo Clinic has reported perforations just after vagotomy.

I have had many duodenal ulcers perforate a second year in succession; several had perforated three years in succession and one individual had a perforated duodenal ulcer once a year for four years in succession. It is probable that if duodenal ulcer is about to perforate in a patient a second time or more, vagotomy will not prevent this occurrence if tenth nerve section is performed about the time the perforation is ready to occur. It is possible that after a patient has recovered from a perforated peptic ulcer operation, vagotomy, some time subsequently, might well prevent repeated perforations provided no obstruction is present at the pylorus.

Obstructing ulcers at or near the pylorus do not lend themselves to vagotomy alone since the resultant atony, lessened peristalsis and delayed emptying of the stomach following vagotomy would aggravate the obstruction. Standard gastric surgical operations, such as resection of the stomach or gastro-enterotomy, may be done successfully, with or without vagotomy, through the abdomen.

* Presented at the Boston City Hospital Alumni Association Clinical Meeting, May 3, 1947, at the Cheever Amphitheater.

Patients with recurrent bleeding peptic or jejunal ulcers in the interval between hemorrhages have been operated upon by me. A bilateral vagotomy through the chest is done; the nerves are resected at the same time.

It is not particularly desirable to perform a vagotomy operation alone on gastric ulcers because of the danger of malignancy.

Many years ago Berg of New York resected the left vagus nerve subdiaphragmatically while at the same time performing a subtotal gastrectomy for duodenal ulcer in young people with a high acidity.

It has been proved that section of one vagus nerve is of little or no value. Both nerves and any communicating branches should be severed and excised to obtain satisfactory results.

The late distinguished surgeon, Dr. Harvey Cushing, maintained that nerve impulses from the brain were the important factors in the cause of peptic ulcers. The recent fine work of Dragstedt in Chicago, Moore in Boston and others has lent confirmation to this belief.

Some fifteen years ago I was the first surgeon at the Boston City Hospital to remove the whole stomach successfully for carcinoma involving both cardiac and pyloric regions of the stomach. An end-to-side anastomosis was performed between the esophagus and jejunum through the abdominal approach. Secondarily, both tenth nerves were sectioned in doing this complete gastrectomy.

Dragstedt has approached this problem by sectioning the tenth nerves above or below the diaphragm, in the latter case often combining vagotomy with standard operative procedures on the stomach and duodenum. Moore has confined his efforts to sectioning and resecting the nerves above and through the diaphragm by means of a transpleural approach alone.

I have operated upon a series of patients, doing a bilateral vagotomy with vagus resection at the Boston City Hospital and elsewhere, with no operative mortality.

A transpleural approach has been made use of in all of my cases since in my hands this method affords the operator a better opportunity of sectioning both cranial nerves and connecting plexuses intact. I have noted considerable differences in the size, shape and position of these tenth nerves as well as the connecting nerve fibers on the esophagus.

If by some adhesions the lung is adherent to the diaphragm or parietal pleura as a result of prior pleurisy, these adhesions must be severed in order to retract the lung properly and approach the esophagus through the posterior mediastinum. Very dense and extensive adhesions of the lung to the diaphragm, which I have encountered, require approach to both tenth nerves through an incision in the diaphragm, into the abdominal cavity, through the transpleural approach. Both tenth nerves below the diaphragm break up in a plexus of nerve fibers making their complete severance more difficult than above the diaphragm. The left anterior vagus nerve is more readily accessible than the right posterior tenth nerve, which may be found posteriorly and further away from the stomach than the anterior vagus branches.

At operation the patient is placed on the right side, and under intratracheal, positive pressure anesthesia the left chest is opened by subperiosteally removing the seventh or eighth rib from the costal cartilage anteriorly to its transverse process attachment posteriorly. A rib spreader is inserted and any adhesions of the lung to the diaphragm or chest wall are separated if possible. If dextrocardia is present, the right chest would be opened. The ligament of the lung is then doubly clamped and tied off, retracting the lung upward and protecting it with moist pads. The posterior mediastinum is opened between the heart and aorta, and by blunt dissection the esophagus with the right and left tenth cranial nerves are pulled into the left chest.

The left anterior vagus nerve is identified

and lifted up on a blunt hook, freeing it from its bed upward toward the hilum of the lung and downward to the diaphragm. The proximal part of the tenth nerve is then injected with 1 per cent novocain solution before it is tied with a gastro-intestinal silk suture distal to the injected area in order to avoid shock. A surgeon's knot is used to prevent the tie coming off the nerve. The distal tenth nerve is then tied off at the diaphragm with catgut, otherwise a small blood vessel accompanying the nerve may bleed. Several centimeters of the vagus nerve are excised and placed by Zenker's solution for examination by the Pathological Department.

The right posterior tenth nerve is treated similarly; then both proximal ends of the nerves are pulled up into the left pleural cavity and sutured to the suture line of the parietal pleura in closing the posterior mediastinum. This procedure prevents nerve regeneration between the proximal and distal ends of the tenth nerves.

About ten minutes are allowed the expert anesthetist to expand the left lung fully. During the operation it is well to expand the left lung partially by positive pressure once or twice.

A small catheter is left in the posterior end of the incision in the most dependent part of the pleural cavity during the chest closure, then the catheter is removed on final closure. A heavy mattress suture, placed temporarily about the adjacent ribs, aids in closure of the chest.

The patient is watched closely for evidence of pneumothorax, fluid in the chest, atalectasis or other respiratory complications. The individual is allowed to be up and about the day after operation. Some patients develop a certain amount of fluid or air in the pleural cavity, despite full expansion of the lung at closure of the chest wall. Others complain of pain in the region of the intercostal nerve which may be anticipated by the injection of nuper-cain in oil in the proximal region of the intercostal nerve before closing the chest.

Some anesthesia in the epigastrium has been noted during convalescence.

Atony of the stomach may necessitate the use of a duodenal tube to relieve a sense of fullness in the stomach and to prevent vomiting. Nature eventually accommodates itself to the lessened peristalsis; and there is no need for a gastro-enterostomy as the pylorus will be found to be patent, if this unnecessary operation is subsequently performed for stomach atony.

Before operation these patients are gastroscoped and the gastric acidity is also noted before and after operation with insulin and histamine tests.

The results of the operation are lessened gastric peristalsis, marked decrease in gastric acidity and a slowing down of the emptying of the stomach due to a certain amount of atony. The patient has a sense of well being; his pain has disappeared. A better than normal appetite develops and the patient gains weight, sleeps well and is surprised that he can eat formerly forbidden fruits, tomatoes, etc. He can now enjoy life and return to work to support the family.

Since the liver, pancreas and intestines as well as the stomach are supplied by the tenth nerves, one would expect that the function of these organs would be affected by this operation. Many of these patients have normal motility and no symptoms a year after operation.

Clinically, the patient often gains 20 to 30 pounds after operation and many develop a ravenous appetite, for instance, eating several orders of ham and eggs or other articles of food at a meal.

These patients are x-rayed before and after operation. Clinically and from an x-ray point of view, the active ulcer disappears in a matter of weeks after operation. Stomach motility returns to normal in many cases. Others, with atony of the stomach and sluggish peristalsis, are clinically well.

Penicillin has been given as a routine, 30,000 units every three hours for twenty-

four hours then 100,000 units every eight hours for three days.

Elsewhere some patients have been operated upon for non-obstructing duodenal ulcer as shown by repeated x-rays, and a transpleural bilateral vagotomy has been performed without relief of symptoms. At subsequent abdominal operation a pathologic condition has been found in the head of the pancreas or elsewhere. At some future date it may be advisable during transpleural vagotomy to open the diaphragm and inspect and palpate the stomach, duodenum, gallbladder, pancreas or other abdominal organs for unknown disorders.

In my opinion, transpleural bilateral vagotomy with resection of both tenth nerves is much simpler, has a lower mortality and is preferable to a partial gastrectomy for intractable non-obstructing duodenal marginal or jejunal ulcers and recurrent bleeding duodenal or jejunal ulcers in the period between hemorrhages.

WILLIAM REID MORRISON, M.D.

CONSIDERATION

THE practitioner or specialist is, in general, almost a god in the eyes of his patient. He is expected to do the superhuman, otherwise a change of doctors would be made. The patient bows reverently to his word of admonition. She or he patiently waits for hours for words of advice, an examination or treatment. This may be in the doctor's office or in a hospital bed or perhaps before or after an operation. In the latter case the doctor may say "I will stop in tomorrow morning." The patient is expectant, looks forward to the visit. Noon comes, lunch is gulped, three, four, five o'clock pass. At seven the doctor appears, tired and relatively uninterested. The disappointed patient has waited expectantly for encouragement all day.

Another case: "we will operate in the morning." At eight the patient is alert; at ten is sent to the operating room all agog, but the doctor telephones that he has been delayed. Another hour passes. This definitely is not a scientific, humane or psychologic approach to successful operative treatment.

In office practice, to cite instances, a young woman in the anxiety of her first pregnancy is kept waiting an hour or more in a crowded waiting room. An advanced postoperative cancer patient is forced to wait for an hour or two to see the master who finally passes a hand over the wound and remarks "fine." An industrialist looking for business and reputation would not presume on the good will of his clients in such a way. How can the medical man justify such an inconsiderate and thoughtless attitude? It shows lack of consideration, lack of business acumen, psychologic inertia and is in fact unconscionable.

He should plan his time and his appointments, allowing an average period for each patient. That this can be done has been adequately demonstrated by the practice of many thoughtful and considerate medical men. The laity would think better of the profession and the individual doctor if this were generally done; the practitioner would believe that he was carrying on more effectively, sympathetically and humanely; in fact, doing a better job.

E. H. POOL, M.D.

Original Articles

MODERN MANAGEMENT OF ACUTE PERFORATED GASTRODUODENAL ULCERS*

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IT has been estimated by Wangensteen[24] that approximately 10,000 individuals died in the United States each year from acute gastroduodenal ulcers and their complications. Autopsies reveal that either a healed or an active gastroduodenal ulcer is present in approximately 5 per cent of individuals examined at the postmortem table. It is a well known fact that acute erosions of the gastric or duodenal mucosa may occur easily. Under experimental conditions in the laboratory fully developed gastroduodenal ulcers can be produced within several hours by allowing gastric juice to drip upon a designated unprotected area of gastric or duodenal mucosa.

History records that the first published report of a perforated gastroduodenal ulcer was made by Boneti[1] in 1679. Fifty years later Rawlinson[18] presented a case history of a perforated gastroduodenal ulcer before the Royal Society in London. It was not until ninety-five years after the report of Rawlinson that John Abercrombie[1] was able to differentiate between the two types of perforated gastroduodenal ulcers. Cruvilhier,[7] the French pathologist, clearly differentiated between a simple gastroduodenal ulcer and an ulcerating gastric carcinoma.

It was not until 1875 that O'Hara[17] became the first American to describe and present an example of a perforated gastroduodenal ulcer before the Philadelphia Pathological Society. The first recorded attempt to close such a perforating ulcer surgically was done by Mikulicz[16] in 1880. This first surgical attempt was unsuccessful. Twelve years later Heussner and Roux[11] were among the first to report a successful surgical repair of a perforated gastroduodenal ulcer. Dean[8] in 1894 reported a successful surgical excision of such an ulcer. Seventeen years after his first published unsuccessful attempt Mikulicz[16] was able to publish a collected series of 103 operations for the surgical repair of perforated peptic ulcers. The majority of these operations were successful.

Perforated gastroduodenal ulcers have always aroused the great interest of internists and surgeons alike and have constituted one of the most dramatic emergency surgical conditions frequently encountered. My interest and study in this subject extends back some twenty-one years in the past. In 1933 Rhodes and I[19] presented a report upon 155 consecutive instances of perforated acute gastroduodenal ulcers that had come under our care on the emergency service at the San Francisco City and County Hospital. These patients had been treated during the ten years between 1919 and 1929; 117 of these individuals had been sur-

gically treated within ten hours following their perforation and 13 per cent of these died. The remaining thirty-eight patients in this series had not received surgical care until more than ten hours had elapsed following their acute perforation and they

TABLE I
RESULT OF MEDICAL TREATMENT OF PEPTIC ULCER—THERAPEUTIC RESULTS IN TOTAL MATERIAL*

Results	Cases	Per cent
Recovered	131	20
Recovered after relapse	21	3
Improved	191	20
Poor result	*184*	*28*
Died	*99*	*15*
Not located	39	6

Medical treatment alone *cannot* permanently heal nor prevent the onset of complications in *all* gastroduodenal ulcers.

* From KRAUP, NIELS B. The 1946 Year Book of General Medicine. Pp. 631. Chicago, 1946. The Year Book Publishers, Inc.

had a mortality rate of 68 per cent. We[19] found that the causes of mortality in this group of 155 patients were due largely to the following complications: peritonitis 50 per cent; cardiac disease 30 per cent; pneumonia 20 per cent. Forty-six per cent of the surviving patients in this series were traced postoperatively for five or more years following their corrective surgery and 85 per cent reported themselves as being either entirely cured or that a prompt return to their prescribed ulcer diet gave prompt relief from symptoms of mild recurrences. The remaining 15 per cent who replied to our questionnaire admitted that they had been guilty of gross neglect and abandonment of the prescribed medical measures designed to prevent recurrences.

In the past fourteen years the surgical world has witnessed tremendous improvement in the surgical management of acute perforated gastroduodenal ulcers. McNealy and Howser[14] as well as Karl Meyer and his associates[26] have made numerous important contributions toward the better management of this disease. They have

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repeatedly stressed the fact that a considerable number of surgically treated perforated gastroduodenal ulcers will subsequently develop symptoms of reactivation of their former ulcer, and a subtotal gastric resection often will be necessary in

TABLE II
PERCENTAGE OF PERFORATED ULCER AMONG ALL ADMISSIONS FOR ULCER AND PERCENTAGE OF READMISSIONS
After Werbal, Kozoll and Meyer

Year	Ulcer Patients Admitted All Types	Perforated Ulcer Patients Sutured and Recovered		Previously Perforated Ulcer Patients Readmitted	
		No.	Per cent of Total Admissions for Ulcer	No.	Per cent of Total Admissions for Perforation
1939	717	96	13	35	26
1940	809	118	14	34	29
1941	764	88	12	36	41
1942	629	89	14	33	37
1943	549	61	11	26	42
1944	436	56	13	39	31
1945	451	66	15	36	39
Total	4,355	574	..	239	31.6

The incidence and fairly constant percentages of reperforation in gastroduodenal ulcers. Closure of the original perforation is *no* guarantee against future reperforations.

certain of these individuals in order to obtain a complete and permanent recovery. Werbel, Kozoll and Meyer[26] have drawn our attention to the fact that in a series of 574 patients suffering from acute perforated gastroduodenal ulcers and in whom a simple closure of the perforation was done 239 individuals, or 41.6 per cent, were forced to return to the Cook County Hospital for further hospitalization, because of a recurrence of their previous symptoms. In 86 per cent of their patients pain was largely responsible for their return to the hospital and a considerable percentage of these individuals suffered from varying degrees of pyloric obstruction; 17 per cent of these re-admitted

patients had two or more acute re-perfora-
tions; 34 per cent of the re-admitted
patients were suffering from recurrent
bleeding from the ulcer crater. (Tables I,
II and III.) Further gastroduodenal surgery
was necessary in 30 per cent of these 239

TABLE III

CAUSES OF DEATH IN EIGHTEEN PATIENTS WITH ULCER
COMPLICATIONS FOLLOWING AN EARLIER
PERFORATED ULCER

(*After Werbal, Kozoll and Meyer*)

	No. Deaths
Reperforation..................................	5
Second perforation.............. 3	
Third perforation.............. 1	
Fifth perforation.............. 1	
Reperforation with Hemorrhage	
(2nd Perforation)...............	3
Hemorrhage.......................	3
Elective surgery..................	5
Gastric resection.............. 3	
Gastroenterostomy............. 2	
Liver abscess four months after	
perforation......................	1
Cerebrovascular accident...........	1
Total.........................	18

Reperforation of a gastroduodenal ulcer is associated
with markedly increased morbidity and mortality.
These deaths were in the patients shown in Table I.

patients who returned to insure them
prompt and permanent relief from their
symptoms. (Fig. 1.)

Werbel, Kozoll and Meyer[26] were of the
definite opinion that a primary subtotal
gastric resection at the time of the patient's
original perforation was not, as a general
rule, indicated; and that any surgical pro-
cedure more extensive than a simple clo-
sure would lead to unnecessary deaths.
Recent published studies by Samayn,[20]
Milaret and Edelman[15] are in sharp vari-
ance with this opinion of Karl Meyer and
his associates. The technic and the indi-
cations for subtotal gastrectomy has shown
marked advancement and refinement in
the last ten years so that today the con-
sensus of opinion of gastric surgeons in this
country is crystallized into the definite
belief that a subtotal gastrectomy is neces-
sary for the permanent and successful cure
of long-standing chronic gastroduodenal
ulcers. In this connection, according to
Frank Lahey[12] and Lewisohn,[13] any sub-
total gastric resection which does not

include the distal two-thirds of the stomach
and the duodenum with its chronic duo-
denal ulcer, if present, will be doomed to
early failure.

Bilateral vagotomy introduced by Drag-
stedt[9,10] has aroused tremendous interest
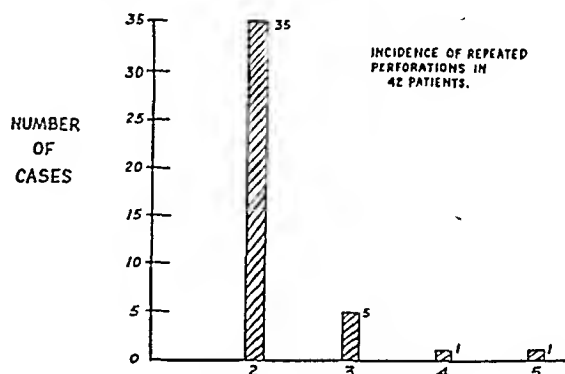
FIG. 1. Number of perforations (after Werbel, Kozoll
and Meyer).

among surgeons and at first the reports
published gave rise to the hope that pos-
sibly this would be the ideal operation for
chronic gastroduodenal ulceration. Recent
reports by Waltman Walters[23] and Wil-
ensky[27] cast considerable doubt as to
whether or not the beneficial advantages
enthusiastically claimed for the routine
use of this operation in cases of chronic
gastroduodenal ulcers are of more than
temporary duration. The fact that fre-
quently a gastric atomy develops, which
must be relieved in many instances by
some type of a gastrojejunostomy, casts
further doubt as to the efficacy of this new
operation. Recently it has been claimed
that there is a return of the patient's
former gastric hyperacidity within a year
after vagotomy. Additional time must be
allocated for critical evaluation of the
benefits of bilateral vagotomy before any
definite opinion can be made. There is a
growing opinion in this country that a
bilateral vagotomy should be reserved for
recurrent stomal ulcerations in patients
in whom a subtotal gastrectomy has been
done previously and in whom the operation
was extensive enough to remove most of
the acid-secreting area of the stomach and
gastrointestinal continuity was re-estab-

lished by some type of a gastrojejunostomy. Therefore, at the present time final judgment must be withheld.

During the last two years three articles have appeared in British medical literature advocating the conservative nonoperative treatment of acute perforated gastroduodenal ulcers. The publication of these articles aroused considerable interest throughout the medical world. The chief advocates of this new method of therapy, namely, Bedford Turner,[3] Visick[22] and Herman Taylor,[21] have possibly been too enthusiastic in their recommendations of this type of therapy. Their combined series of cases numbered less than fifty patients and their admitted mortality from this method of treatment is still greatly in excess of that obtained from a simple surgical closure of acute perforated ulcers in this country.

To illustrate what can be done when prompt and energetic surgical care is exercised on individuals suffering from this pathologic entity, Baritell[2] reported upon a consecutive series of eighty-eight patients operated upon for acute perforated gastroduodenal ulcers. (Table IV.) There was only one death, a mortality of 1.1 per cent. This mortality is far less than that presented by the advocates of conservative medical care for this pathologic entity. When a careful study is made of the reported mortality and morbidity in the articles by these three British authors, needless deaths and preventable complications are revealed that would not have occurred had they been treated promptly by surgical measures.

It was thought that the surgical records of an average private city hospital covering an eleven-year period between 1937 and 1947 on consecutive unselected case histories of proven perforated gastroduodenal ulcers might prove of interest; thirty-six such case histories treated surgically were collected. There were six deaths, or a mortality rate of 16.7 per cent; thirty of these individuals were males and there were three deaths in both sexes. The thirty

males averaged 39.4 years in age while the remaining six females had an average age of 67.6 years. Twenty-five instances or 69.5 per cent of this pathologic entity occurred during the winter and spring months with four deaths. In the first five-

TABLE IV
MOST RECENTLY PUBLISHED MORTALITY RATES FOR PERFORATED PEPTIC ULCER
(*After Baritell*)

Author	Year	No. of Cases	Per cent Mortality
Baritell, A. L.	1946	88	1.1
Tilton, B. J.	1936	52	2.0
Graham, R. R.	1938	62	3.2
McClure, R. D.	1940	91	7.7
Estes, W. L. and Bennett, B. A.	1944	80	8.7
Black, B. M. and Blackford, R. E.	1945	93	12.0
Barber, R. F. and Madden, J. L.	1943	86	12.8
Hartzell, J. B. and Soroek, M. L.	1939	39	12.8
Marshall, S. F. and Keleher, P. C.	1940	46	13.0
Raw, S. C.	1944	312	14.4
Cohn, R.	1941	300	15.0
Berson, H. L.	1942	151	15.2
Ross, J. C.	1940	175	16.0
Paletta, F. X. and Hill, W. R.	1943	83	16.9
DeBakey, M. and Odom, C. B.	1940	211	17.3
Ross, A. and LaTourneau, G.	1939	220	17.7
Donald, D. C. and Barkett, S. M.	1942	116	18.5
Meade, R. H.	1943	68	19.1
Timoney, F. X.	1943	246	19.5
Griswold, A. R. and Antoncic, R.	1941	102	19.6
Fallis, L. S.	1938	100	20.0
McCreery, J. A.	1938	170	20.5
Eliason, E. L. and Thigpen, G. M.	1938	70	21.4
Sangster, A. H.	1939	100	23.0
O'Donoghue, J. B. and Jacobs, M.	1942	200	24.5
McCabe, E. J. and Mersheimer, W.	1943	87	25.2
Martz, H. and Foote, M. H.	1940	50	26.0
Parker, E. F.	1941	52	27.0
Davidson, T. C. and Rudder, F. F.	1940	155	28.0
Thompson, H. L.	1939	424	28.7
Hartzell, J. B. and Soroek, M. L.	1939	234	28.9
Reed, J. C.	1938	100	30.0
Collins, D. C.	1947	36	16.7

year period, between 1937 and 1941, there were thirteen examples (36.1 per cent) with three deaths; while the years between 1942 and April, 1947, revealed a lowering of the hospital mortality in which there

had been twenty-three instances (63.9 per cent) with three deaths. This lowered mortality in the past five years may be partially attributed to the wide spread use of antibiotics and specific chemo-

TABLE V

RESUME OF PEPTIC ULCER SURGERY (1937–1947)

Gastric Ulcers

Type	Cases	Deaths	Males	Fe-males	Mortality, Per Cent
Non-perf.	433	30	22	8	6.93
Acute perf.	12	3	0	3	25.00

Duodenal Ulcers

Non-perf........	757	34	29	5	4.49
Acute perf.......	22	3	3	0	13.62

Total Gastroduodenal Ulcers

Non-perf	1,190	64	51	13	5.37
Acute perf.......	36 (2-location not stated)	6	3	3	16.68
Totals.........	1,226	70	54	16	5.71

RATIOS:

Gastric Ulcers

Ratio: Non-perf. gastric ulcer to acute perf. gastric ulcer = 3.60:1
Ratio: Mortality acute perf. gastric ulcer to non-perf. gastric ulcer = 3.6:1

Duodenal Ulcers

Ratio: Non-perf. duod. ulcer to acute perf. duod. ulcer = 34.8:1
Ratio: Mortality acute perf. duod. ulcer to non-perf. duod. ulcer = 3.0:1

Gastroduodenal ulcers

Ratio: Non-perf. gastroduod. ulcers to acute perf. gastroduod. ulcers = 33.1:1
Ratio: Mortality acute perf. gastroduod. ulcers to non-perf. gastroduod. ulcers = 3.1:1

therapy. Twenty-eight patients, or 77.8 per cent, had had ulcer symptoms for more than one year prior to their acute perforation and fourteen (38.9 per cent) of these thirty-six patients admitted under persistent questioning that their symptoms referrable to their old chronic gastroduodenal ulcer had been present in excess of ten years. (Tables v to ix.)

The duration of acute symptoms of perforation before surgical closure was performed was as follows: fifteen individuals or 41.7 per cent had symptoms of per-

foration for less than six hours, while the remaining twenty-one or 58.4 per cent presented severe symptoms and signs typical of perforation for more than six hours. One-half of the patients in this series had correct preoperative diagnoses

TABLE VI

AGE DISTRIBUTION IN EIGHTY-EIGHT PATIENTS OPERATED UPON FOR PERFORATED PEPTIC ULCERS
(After Baritell)

Age	No. of Patients	Per cent of Patients
Under 20	0	0.0
20–29	12	3.6
30–39	23	26.1
40–49	26	29.5
50–59	19	21.6
60–69	7	8.0
70–79	1	1.1

made with an exact location of the anatomic site of perforation. There were eight incorrect preoperative diagnoses: five were diagnosed as acute appendicitis, two were thought to be acute cholecystitis and one

TABLE VII

TABULATION OF EIGHTY-EIGHT PATIENTS OPERATED UPON FOR PERFORATED ULCER—ACCORDING TO TIME ELAPSED BETWEEN PERFORATION AND SURGERY—WITH COMPARISON TO COLLECTED SERIES
(After Baritell)

Hours Elapsed	No. of Patients	Our Series		Collected Series of DeBakey	
		Per cent Patients	Mortality	Per cent Patients	Per cent Mortality
0–6	34	38.63	...	50.83	10.5
0–12	37	42.04	...	31.02	21.4
12–18	13	14.77	...	3.03	38.5
18–24	2	2.27	...	1.43	62.4
Over 24	2	2.27	...	13.66	61.5
All cases	88	100.00	1.1	100.00	22.4

was considered an acute small bowel obstruction. Unfortunately these eight incorrect diagnoses resulted in an improper surgical incision being made which of necessity had to be closed in seven in-

stances and a new one made. This caused a definite lengthening in the patients' time upon the operating table and was a definitely increased risk to their ultimate recovery. One-half of these patients were seen on emergency visits at their homes and

TABLE VIII
AGE DISTRIBUTION IN THIRTY-SIX PATIENTS OPERATED UPON FOR PERFORATED PEPTIC ULCERS

Age	No. of Patients	Per cent of Patients
Under 20	1	2.78
20–29	2	5.56
30–39	12	33.36
40–49	4	11.12
50–59	10	27.80
60–69	4	11.12
70–79	3	8.34

all of them received a narcotic injection and the correct diagnosis was *not* made until a number of hours later on a subsequent emergency house call. Twenty-five per cent of the entire series received multiple narcotic injections which resulted in a needless and dangerous delay before a correct preoperative diagnosis could be made.

TABLE IX
SEASONAL INCIDENCE

Season	No. of Cases	Per cent	Deaths
Winter	11	30.5	1
Spring	14	38.9	3
Summer	4	11.1	1
Fall	7	19.5	1

The operating time upon these patients varied from 15 minutes to 185 minutes. The average operating time for these patients was in the neighborhood of one hour; 41.7 per cent of all the patients in this series left the operating room before forty minutes had elapsed. (Tables x to xiv.)

The postoperative complications and the morbidity in this series are of interest. Two patients suffered from a post-operative eventration of their wound with

one death. One patient had to have a subsequent disconnection of an anterior gastrojejunostomy. Another male developed a huge pelvic abscess which drained rectally. Two additional patients had subsequent drainages of large intra-abdom-

TABLE X
DURATION OF PREVIOUS SYMPTOMS

More Than (yr.)	No. of Patients	Per cent of Total Cases
1	28	77.84
5	22	61.16
10	14	38.92
20	4	11.12
None	1	2.78

inal abscesses while two other individuals required drainages of large subdiaphragmatic abscesses before they recovered. All of these last six individuals lived. Fifteen patients, or 41.7 per cent suffered

TABLE XI
TABULATION OF THIRTY-SIX PATIENTS OPERATED UPON FOR PERFORATED ULCER ACCORDING TO TIME ELAPSED BETWEEN PERFORATION AND SURGERY—WITH COMPARISON TO COLLECTED SERIES

Hours Elapsed	Our Series		Mortality		Collected Series of DeBakey	
	No. of Patients	Per cent Patients	No.	Per cent	Per cent Patients	Per cent Mortality
0–6	15	41.70	..	.....	50.83	10.5
0–12	6	16.68	2	33.33	31.02	21.4
12–18	4	11.12	1	25	3.03	38.5
18–24	1	2.78	..	.....	1.43	62.4
Over 24	10	27.80	3	30	13.66	61.5
All cases	36	100.00	6	16.68	100.00	22.4

from varying degrees of infection of their surgical incisions. Four persons developed postoperative bronchial pneumonia; three aditional persons suffered from acute pneumonitis and three cases had postoperative genitourinary tract infections.

There were 45 surgical procedures performed upon these thirty-six patients (Figs. 2 to 6); fourteen individuals, or 38.9 per cent, had a simple closure of the perforation employing mattress sutures of one

TABLE XII
OPERATIVE TIME*

Total Time (min.)	No. of Cases	Per cent	Deaths
0–20	2	5.56	0
21–40	13	36.14	1
41–60	10	27.80	3
61–80	4	11.12	1
81–100	3	8.34	0
101–120	0		
121–140	1	2.78	0
141–160	1	2.78	0
161–180	1	2.78	1
181–200	1	2.78	0

* Apparently, prolonged operative time is *not* a major factor in mortality in acute perforated gastroduodenal ulcers.

type or another, with three deaths; ten patients, or 27.8 per cent, were treated by the method of Werbel, Kozoll and Meyer[25] using a free omental graft sutured over the perforation, with one death. The remaining operative procedures are listed on Table XIV and are self-explanatory. Thirty-

TABLE XIII
POSTOPERATIVE MORBIDITY

Condition	No. of Cases	Per cent
Infected wounds	15	41.10
Acute pneumonitis	3	8.34
Bronchopneumonia	4	11.12
Genitourinary tract infection	3	8.34

five operative procedures, or 77.9 per cent, were performed under spinal anesthesia; Table XV cites the additional data concerning the types of anesthesia used.

Concerning the problem of draining the peritoneal cavity, thirteen patients or 36.1 per cent had drainage of various portions of the peritoneal cavity, with three resulting deaths. The remaining twenty-three persons or 63.9 per cent did *not* have drainage of the peritoneal cavity and only

three of these died. Twenty-seven and eight-tenths per cent of this series had had preoperative x-ray scout films taken of the abdomen and eight of the ten individuals thus studied revealed the presence of free

TABLE XIV
OPERATIVE PROCEDURES

Operation	No. of Cases	Per cent	Deaths
Simple closure	14	38.92	3
Omental graft sutured over perforation	10	27.80	1
Pylorectomy, post. gastro-enterostomy	1	2.78	0
Pylorectomy, duodenectomy, Finney oper.	2	5.56	0
Pyloroplasty, Judd type	3	8.34	0
Purse-string closure	3	8.34	2
Two suture row formal closure	3	8.34	0

gas beneath the leaves of the diaphragm and were of definite diagnostic value.

Table XVI lists the size of the perforated gastroduodenal ulcers encountered in this series and as described in the surgeon's dictation of his operative findings. There were fourteen ulcers (38.9 per cent) in this series that were situated on the gastric

TABLE XV
DATA ON ANESTHESIA FORTY-FIVE OPERATIONS IN THIRTY-SIX PATIENTS

Agent	No. of Cases	Per cent	Deaths
Spinal	35	77.9	5
Ether	3	6.6	0
Cyclopropane, O_2	2	4.4	0
Ethylene, ether, O_2	1	2.2	0
Ethylene, O_2	1	2.2	0
Chloroform, O_2	1	2.2	1
Local, 1% procaine	2	4.4	0

side of the pyloric ring and the remaining twenty-two (61.2 per cent) were situated in the first portion of the duodenum. Twenty of the duodenal ulcers were anterior and two were stated as being on the posterior wall of the first portion. Figure 7 gives the salient points on the anatomic location of these ulcers.

Since 1942 when the use of specific chem-

D. Sutures in place at site of ulcer.

B. Ulcer exposed.

C. Resecting Omental graft.

OMENTUM

DESC. COLON.

A. Line of Incision.

H. EICHNER Fecit 1947

E. Omental graft in place over suture.

F. Sutures tied

H. SAGITTAL SECTION SHOWING LOCATIONS OF FLUID

LIVER

H. EICHNER Fecit 1947

G. Closure of Incision

end-on mattress sutures

All layers of wound closed with permanent interrupted sutures.

Gutta-percha drain

FIGS. 2 to 6. These depict a recommended operative technic that in our experience has proved to be the safest method of treating acute perforated gastroduodenal ulcers. The sagittal section of the peritoneal cavity in Figure 5 depicts seven areas within the peritoneal cavity that are always systematically aspirated dry to minimize the occurrence of dangerous postoperative intra-abdominal abscesses.

otherapy made its appearance and when the intraperitoneal implantation of various types of sterile sulfonamide powders was begun, there has been a definite lowering of the mortality 'rate. Eighteen patients

FIG. 7. Anatomic locations of thirty-six peptic ulcers; location of two ulcers not stated.

(50 per cent) were so treated, using specific chemotherapy and only two patients died. The intraperitoneal use of penicillin was begun in 1945. It has been employed in eight patients with no deaths. Streptomycin was first employed in 1946 and has

TABLE XVI
SIZE OF DIAMETER OF ULCER PERFORATIONS

Gastric Ulcers		Duodenal Ulcers	
Size (cm.)	Cases	Size (cm.)	Cases
Not stated	8	Not stated	8
0.5	1	Pin point	1
1.0	2	0.25	2
1.5	1	0.5	5
2.0	1	0.75	3
3.0	1	1.0	2
		5.0	1

been administered to four patients with no deaths. Thus, specific chemotherapy has been used in eighteen patients with two deaths and antibiotics have been used in the past two years in an additional twelve patients with no deaths. It is believed that the use of specific chemotherapy and specific antibiotics has done much to lower the postoperative mortality in thirty (83.4 per cent) of the thirty-six patients comprising this series.

The extremes in hospital stay of those who survived their surgical treatment varied between 5 and 144 days. The average hospital stay for all hospital cases was 22.6 days; seven patients stayed in the

TABLE XVII
DATA ON WHITE BLOOD COUNTS

W.B.C.	Cases	Per cent	P.M.N.%	Cases	Per cent
Over 20,000	9	25.02	100	1	2.78
Over 15,000	13	36.14	Over 90	12	33.36
Over 10,000	11	30.58	Over 85	13	36.14
Over 5,000	2	5.56	Over 80	2	5.56
			Over 70	5	13.90
			Over 50	3	8.34

hospital less than nine days, six of whom died.

The laboratory studies (Table XVII) on this group of patients were of interest. The preoperative urine analyses of sixteen individuals (44.5 per cent) showed positive albumen reactions and an additional seventeen patients (47.3 per cent) had positive glycosuria tests; six patients gave positive acetone reactions in the urine and three revealed a positive urinary test for diacetic acid. The white blood count was of diagnostic value: nine patients (25.0 per cent) had white blood counts over 20,000; thirteen (36.1 per cent) had white counts varying from 15 to 20,000; eleven patients (30.6 per cent) revealed white blood counts varying between 10 and 15,000 and two patients (5.6 per cent) had normal blood counts between 5 and 10,000; finally, one patient (2.8 per cent) had a leukopenia of 3,350 white cells. This patient died.

The differential polymorphonuclear neutrophile cell counts revealed the following data: one individual (2.8 per cent) had 100 per cent; twelve persons (33.4 per cent) were between 90 and 100 per cent; thirteen patients (36.1 per cent) were between 85 and 90 per cent; two individuals (5.6 per cent) were between 80 and 85 per cent and the eight remaining (22.2 per cent) lay in the range of normal.

Karl Meyer and his associates[26] empha-

size that in their large series of patients re-perforation in previous acute perforating gastroduodenal ulcers is usually in the neighborhood of 4 per cent. Three patients (8.3 per cent) in this series had had previous acute perforating gastroduodenal tunately, all three patients survived under a regimen of massive chemotherapy and antibiotic medications.

Seventeen different surgeons operated upon this series of thirty-six patients. Seven surgeons performed twenty-six or

TABLE XVIII

PREVIOUSLY REPORTED LATE RESULTS OF ACUTE PERFORATED PEPTIC ULCER TREATED BY SIMPLE SUTURE

(*After Baritell*)

Author	Year Re-ported	No. of Cases Followed	No. of Cases Well	No. of Cases Not Well	No. of All Followed Cases Having Reoperation
Eliason and Thigpen	1938	22	15(70%)	7(30%)	4(18%)
Cable, J. V.	1938	24	2(8%)	22(98%)	4(16%)
Thompson, H. L.	1939	49	12(24.4%)	37(75.6%)	2(4%)
Parker, E. F.	1941	18	6(33%)	12(67%)	6(33%)
Harrison, C. and Cooper, W., Jr.	1942	39	7(17.5%)	32(82.5%)	
Estes, W. L. and Bennett, B. A.	1944	53	3(5.6%)	50(94.4%)	8(15%)
Williams, A. C.	1944	100	28(28%)	72(72%)	11(11%)
Illingsworth, C. F. W., Jamieson, R. A. and Scott, L. D.	1946	773	77(10%)	541(70%)	155(20%)
Forty, Frank	1946	100	47(47%)	38(38%)	14(15%)
Collins, D. C.	1947	36	27(75%)	6(17%)	3(8%)

TABLE XIX

DEATHS

Cases	1	2	3	4	5	6
Correct preoperative diagnosis	Yes	*No**	Yes	Yes	Yes	*No*
Elapsed time of perforation	168 hr.	*60 hr.*	7½ hr.	60 hr.	*17 hr.*	9½ hr.
Location of ulcer	Post-G.U.	Ant. D.U.	Ant. G.U.	Ant. G.U.	Ant. D.U.	Ant. D.U.
Anaesthesia	Spinal	Spinal	Spinal	Spinal	Spinal	Chloroform, O_2
Upper right rectus incision	Yes	*No*	Yes	Yes	Yes	*No*
Operation time (min.)	60	*177*	45	52	34	*75*
Postmortem	Yes	Yes	No	No	Yes	No

* Underlined portions of this table are believed to be possible major factors in the causation of deaths in this study.

ulcers which previously had been repaired surgically. Two individuals were males, aged sixty-two and forty years. The third person was a woman, aged fifty-one. The two males had had a previous repair of an acute perforated gastroduodenal ulcer three and five years previously, respectively. The remaining woman had had a former acute perforation twenty-eight days prior to her entry into this hospital. For-

72.3 per cent of the operations, with four deaths. One surgeon operated upon nine patients with one fatality. (Tables XVIII and XIX.)

CONCLUSIONS

1. A report is presented detailing the experiences encountered in an average metropolitan hospital in which thirty-six instances of acute perforated gastroduo-

denal ulcers occurred between the years of 1936 and April, 1947. Six patients died, or a total mortality of 16.7 per cent. This mortality figure compares favorably with that reported in surgical literature but should be markedly reduced in the future.

2. Most of the fatalities in this series occurred in patients who were not seen by the surgeon until a very considerable lapse of time had occurred between the onset of their acute perforation and its surgical closure. Several of these fatalities were needless, because the patients had persistently failed to follow the advice given by their physician to have their chronic gastroduodenal ulcer corrected surgically when there would have been a minimal mortality in the hands of the competent surgeon.

3. Indications point out that probably in the near future the excessive mortality resulting from acute perforating gastroduodenal ulcers may be markedly lowered by the skillful employment of various specific chemotherapeutic agents and specific antibiotics which are now freely available for civilian use.

4. A sincere plea is made *not* to treat these patients by conservative medical methods, employing intragastric suction and intravenous fluids as has been recommended recently by several authors in British medical literature. The prompt employment of a simple surgical closure of the perforation will definitely result in lowered mortality and less postoperative morbidity than the use of conservative medical measures. A publication[6] describes the histories of five patients treated by medical measures only and who were later referred to me in extremis. This inadequate medical care caused a needless marked financial loss to the patients as well as placing their lives in needless grave jeopardy. Heroic measures were necessary before these five patients could be removed from the critical list and dismissed well.

5. It is believed that a similar study presented ten years hence will undoubtedly show a marked reduction in the operative mortality and postoperative morbidity in patients surgically treated for acute perforated gastroduodenal ulcers in the future years at this same hospital.

6. The salient points of this study have been summarized in chart form and are self-explanatory.

7. The ratio of non-perforated gastroduodenal ulcers to acute perforated instances in this study was 33.1 : 1. Therefore, it required 1,191.6 operations performed upon non-perforated gastroduodenal ulcers, before the thirty-six instances of acute perforated gastroduodenal ulcers were encountered in this study which covered a period of eleven years.

8. The fact that the operative mortality of acute perforated gastroduodenal ulcers as contrasted to that of non-perforated examples was 3.1 : 1 testifies to the importance of operating upon patients with gastro-duodenal ulcers before acute perforation occurs.

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NOT all bleeding ulcers require surgical treatment; the vast majority will do well under conservative medical regimen. Older patients, especially those with arteriosclerosis and hypertension, occasionally will bleed to death unless immediately operated upon and the bleeding is effectively controlled. Clinically, one can reasonably suspect he is dealing with such a patient if he is unable to maintain a stable circulation using 1,500 cc. or less of blood per transfusion once daily. If larger transfusions are needed, the patient obviously is bleeding extensively and presumably a large artery has been eroded and there is little likelihood of spontaneous cessation of the hemorrhage, whether because the vessel wall is sclerosed or only partially severed and therefore cannot contract. In any event immediate surgery is indicated. (*Richard A. Leonardo, M.D.*)

CARCINOMA OF THE BREAST*

PRESENT STATUS OF THERAPY

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IT is a remarkable thing that for over a half century the radical operation for cancer of the breast has been a *sine qua non* for breast cancer therapy. Attempts to improve the end results of this disease have been in the form of adjuncts to its operative treatment, such as pre- and postoperative irradiation, prophylactic and therapeutic castration and prophylactic and therapeutic androgenic therapy. It is the purpose of this paper to review the present status of the treatment of carcinoma of the breast with special reference to the various adjuncts.

In Maryland cancer of the breast causes more deaths than cancer of any other site in women. In 1946, 302 individuals succumbed to this disease. This is approximately one-fourth of all female deaths from cancer in this state. In the last twenty years the number of deaths has
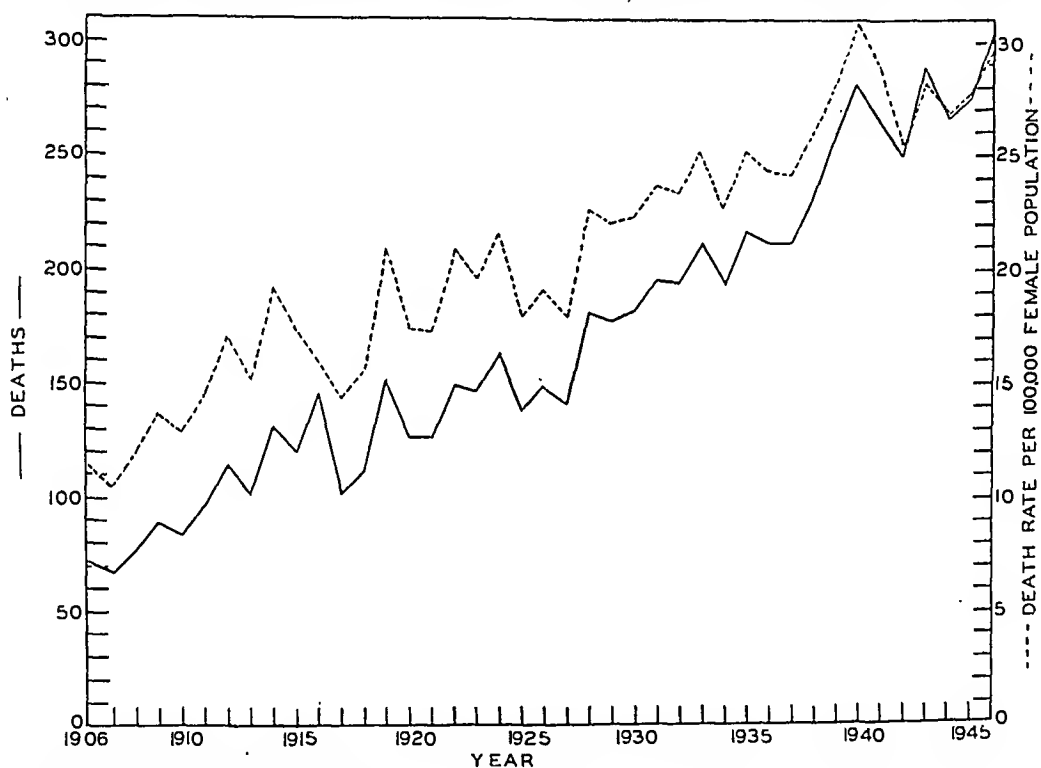
FIG. 1. Deaths and death rates (per 100,000 female population) of females from cancer of the breast in Maryland, 1906 to 1946.

about doubled. That other factors besides an increase in female population is in operation is indicated by the fact that the rate per 100,000 females has steadily risen.[1] (Fig. 1.)

EARLY DIAGNOSIS OF CARCINOMA OF BREAST

If improved results are to be obtained by present therapeutic methods, early

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diagnosis and treatment are imperative. That some progress in this direction is being made is indicated by Harrington's[2] figures which show that in the interval from 1910 to 1914 only 32 per cent of all women had had symptoms less than six

TABLE I
ELAPSED TIME: FIRST SYMPTOM TO OPERATION

Less Than 2 Mo.	2–4 Mo.	4–6 Mo.	Over 6 Mo.
58 (26%)	41 (19%)	27 (12%)	95 (43%)

months prior to medical consultation, whereas, from 1935 to 1939 this figure had risen to 56.4 per cent. That much work in the field of lay education may yet be done is indicated by the fact that between the years 1932 to 1942 inclusive only 57 per cent of patients in the series of 221 ward cases from the Johns Hopkins Hospital herein reported sought treatment within six months of the onset of symptoms. The similarity of this figure to Harrington's is remarkable. (Table 1.)

Although it is impossible to overemphasize the importance of early diagnosis and the lay education directed thereto, it is equally important to note that even a completely successful campaign to this end is by no means the answer to the breast cancer problem.

Even in those individuals operated upon within two months of the onset of symptoms there is a very definite and perhaps irreducible five-year mortality. A sizable percentage of these individuals have axillary metastasis when first seen in spite of a short clinical history. It seems reasonable to suppose that the cancer in the individual is of a particularly malignant variety. (Table II.)

As long ago as 1913 The American Society for the Control of Cancer sponsored an organized campaign for lay education and early diagnosis. Routine periodic examinations were advised but it was not until the close of World War II

that the same organization, now called The American Cancer Society, sponsored detection centers in Maryland and elsewhere. At these centers unsuspected breast cancer is searched for as a part of the routine examination.

TABLE II
END RESULT TO DURATION OF SYMPTOMS

Duration of Symptoms	Less than 2 Mo.		Over 6 Mo.	
	Living	Dead	Living	Dead
Nodes negative pathologically............	20	6	11	10
Nodes positive pathologically............	6	26	25	49

In Maryland during the first year of operation of such centers 1,373 women were examined and two individuals were found in whom it was possible to make a clinical diagnosis of breast cancer. Furthermore, about twenty additional individuals had breast nodules, the nature of which demanded microscopic diagnosis. Unfortunately, follow-up studies on these individuals are not complete so it is impossible to report the exact number of breast cancers other than the two which could be diagnosed by clinical examination. Webster,[3] reporting on 1,600 examinees in Illinois, found ten unsuspected malignant growths of the breast. In this connection it is interesting to note that forty-one of 1,623 primary ward breast cancers reported by Haagensen[4] were diagnosed by routine examinations of patients for other complaints. This represented 6.6 per cent of the entire series. In contrast there is but a single patient among the 221 cases reported in whom an unsuspected cancer was discovered during the course of a routine physical examination for another complaint.

SURGICAL TREATMENT OF CARCINOMA OF THE BREAST

It was previously mentioned that the radical operation is a *sine qua non* for breast cancer therapy. That it is important to pause to re-emphasize this point is indi-

TABLE III

RELIABILITY OF CLINICAL EXAMINATION OF AXILLA

Nodes Not Palpable (78 Cases)		Palpable Nodes (143 Cases)	
Nodes Positive Pathologically	Nodes Negative Pathologically	Nodes Positive Pathologically	Nodes Negative Pathologically
34 (44%)	44 (56%)	116 (81%)	27 (19%)

cated by the fact that within the last year at least four patients presented themselves for treatment at the Tumor Clinic at the Johns Hopkins Hospital with massive local recurrence following simple mastectomy in individuals in whom no contraindication of the radical operation could be found to exist. Furthermore, one of the two patients with cancer of the breast found in Maryland Detection Centers last year was treated by simple mastectomy because, according to the report of the surgeon, no axillary nodes were palpable.

In some sections of the country the use of simple mastectomy proved so widespread that Bransfield and Castigliano[5] presented a report on this subject before the American Radium Society in Cleveland in 1941. That simple mastectomy with or without supplementary irradiation is not the best therapy for breast cancer is indicated by three clinical observations:

1. A definite rate of cure exists in patients with axillary metastasis. In the present series of 221 ward cases 141 had pathologically proven axillary metastasis. Of these, thirty-nine or 26 per cent are living at the end of five years. If these patients had not had an axillary dissection,

a substantial number, if not all, would have been dead.

2. The status of the axilla cannot be determined by clinical examination. In 143 patients with palpable axillary nodes 19 per cent did not have cancer as determined by a microscopic examination. On the other hand, among seventy-eight patients without palpable nodes, 44 per cent were found to be positive by microscopic examination. (Table III.)

3. It is unlikely that irradiation can control breast cancer metastatic to axillary nodes. Because of the difficulty in proving the presence of cancer microscopically before treatment, no satisfying study of this subject exists. However, only about 25 to 35 per cent of breast cancers[6,7] can be sterilized in the breast by preoperative irradiation. Because of inferior blood supply to the axilla and the general resistance of metastatic cancer in lymph nodes, it is reasonable to assume that the rate of sterilization is substantially lower than in the breast itself.

These three clinical observations, 26 per cent rate of cure with axillary metastases, inaccuracy of clinical examination of the axilla and inability to cure axillary metastases with irradiation, indicate that simple mastectomy has no place in the treatment of operable breast cancer in individuals in whom there is no constitutional contraindication to operation. Furthermore, the literature contains no series which would support simple operation.

PREOPERATIVE IRRADIATION

It is generally agreed that preoperative therapy has not added to the total salvage in operable breast cancer.[6,7] For the most part it has been given up as a routine method of therapy. However, this is not to say that it is not a useful adjunct in the rare case of borderline operability. Our own material is not extensive enough for a statistical analysis on this point but the case reported herein emphasizes its usefulness in an occasional case.

CASE I. M. S. aged fifty, was admitted to the Tumor Clinic of the Department of Surgery of The Johns Hopkins Hospital on October 9, 1940. There had been a lump on the right breast of at least one year's duration. Ulceration of the skin was noted two months prior to admission. (Fig. 2.)

Physical examination revealed the right breast to be involved by a hard mass and an ulcerated lesion 4 cm. in diameter above and to the right of the nipple. There were no palpable axillary lymph nodes. She was seen by Dr. Grant Ward who suggested preoperative irradiation. She received 2,400 r (air) of x-ray through an anterior portal and a similar amount through a posterior portal and 1,7000 r to the axilla, 1,900 r through a tangential portal to the breast and 1,000 r directly to ulcerated lesion 200 KV, 50 cm. S. T. D., Thoreaus filtration. Response from the x-ray therapy was very satisfactory and on December 20, 1940, the radical operation was carried out. A pathologic examination proved the diagnosis of carcinoma of the breast with axillary metastasis. The patient was last seen on October 14, 1947, at which time there was no evidence of a recurrence.

It is well to emphasize that a case considered inoperable on first examination should not be committed irrevocably to irradiation as some patients, considered borderline or inoperable cases, can be successfully operated upon after proper x-ray therapy.

POSTOPERATIVE IRRADIATION

The literature is not unanimous in the evaluation of postoperative prophylactic roentgen therapy. In an eleven-year period beginning in 1932, 304 ward patients were admitted to the Johns Hopkins Hospital. Of these, fifty-two or 17 per cent were inoperable and were treated by x-ray and, in some instances, simple mastectomy. Of the remaining 252 patients, 221 were followed up for five years or longer and form the basis for the statistical evaluation of postoperative roentgen therapy. (Table IV.) One hundred three patients received no x-ray therapy while the remaining 118 received at least 2,000 r (air) to an anterior

FIG. 2. M. S., October 9, 1940, treated with preoperative roentgenotherapy and radical mastectomy; living and well seven years later.

portal and 2,000 r to a posterior portal within four months of the radical operation. Factors: 200 K. V. 20 M. A. 15 cm. by 15 cm. portals, 50 cm. T. S. D. Thoreus filtration; treatments 200 r per day on alternate portals.

TABLE IV

OPERABILITY OF CARCINOMA OF BREAST
WARD CASES, JOHNS HOPKINS HOSPITAL 1932–1942

Year	Total	Inoperable of Simple Mastectomy	Primary Operable	Determinate Primary Operable
1932	19	3	16 (2)*	14
1933	36	6	35 (5)	25
1934	30	8	22 (3)	19
1935	30	6	24 (5)	19
1936	29	8	21 (2)	19
1937	25	2	23 (1)	22
1938	24	3	21 (2)	19
1939	31	4	27 (5)	22
1940	33	5	28 (3)	25
1941	25	2	23 (2)	21
1942	22	5	17 (1)	16
	304	52	252 (31)	221

*Number of five-year unfollowed cases in parenthesis.

Table V shows the cases according to the pathologic findings in the axilla. It must be concluded that no statistical difference exists between the group receiving roentgen therapy and the group treated only by operation. Furthermore, the survival time in cases in which patients succumbed within five years does not differ in the two groups. (Fig. 3.)

The over-all five-year salvage is 74 of 221 or 34 per cent. In an institution in which radical operation has been standardized for over half a century, these findings may be of more than passing interest.

cancer and (2) as a prophylactic measure at the time of radical mastectomy.

To Schinzinger[8] belongs the credit of suggesting oophorectomy in advanced cancer as a therapeutic method although he
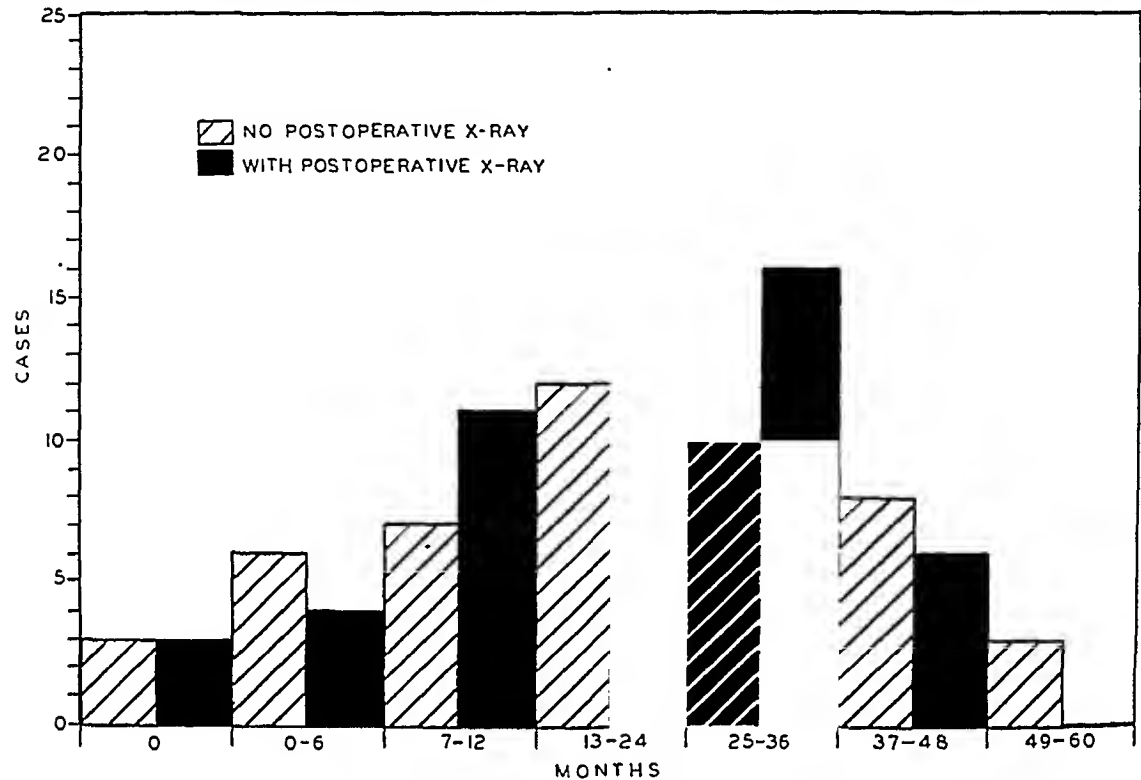
FIG. 3. Length of life in carcinoma of the breast with pathologically positive axillary nodes.

TABLE V
FIVE-YEAR END RESULTS

Therapy	Nodes Negative Pathologically		Nodes Positive Pathologically	
	Living	Dead	Living	Dead
Without postoperative x-ray......	22 (63%)	13	19 (28%)	49
With postoperative x-ray...........	25 (71%)	10	20 (24%)	63
Total..............	47 (66%)	23	39 (26%)	112

CASTRATION AS AN ADJUNCT TO THERAPY

Castration has been advised for the treatment of breast cancer under two circumstances: (1) as a therapeutic method in inoperable or recurrent and metastatic

apparently made no report subsequent to his suggestion at the Surgical Congress in Germany in 1889.

Beatson[9] published the first actual case report of a single patient with improvement. Since then a series of papers on the subject has appeared, especially during the era prior to the general use of x-ray therapy but continuing sporadically to the present time so that case reports now number several hundred. The most remarkable aspect of this subject is the almost complete unanimity in reporting up to 50 per cent definite but temporary satisfactory end results Bone metastases are most favorably affected and recalcification has been observed. Relief of pain without roentgenographic evidence of change has also been observed. The similarity of these

cases to those receiving androgenic therapy is striking.[8, 10-19]

If irradiation is used against a local lesion in addition to castration, the effect is more difficult to evaluate and is overshadowed by the local radiologic response. Thus Ahlbom[20] treated the metastatic areas with x-ray and, in addition, insisted on roentgen castration. By this method in 163 cases it was impossible statistically to demonstrate any increase in the length of life of the castrate group.

The rationale of prophylactic castration at the time of radical operation presupposes the desirability of eliminating all possible estrogen from the organism. It should be pointed out, however, that oophorectomy by no means insures the complete absence of estrogen. Zundek and von Euler,[21] Robson et al.,[22] Frank[23] and Laroche et al.[24] demonstrated up to 200 mouse units of estrogen per L. of urine in menopausal and completely castrate women.

Be this as it may, the absence of ovarian function seems to be associated with a decreased incidence of breast cancer and a lesser likelihood of recurrence although there is not unanimity of opinion.

Herrell[25] reviewed the records of 1,906 women treated for breast cancer and 1,011 women of similar age group as controls. In the cancer group the evidence of complete oophorectomy before the treatment of cancer was 1.5 per cent. On the other hand, the incidence of bilateral oophorectomy in the control group was 15.4 per cent or ten times as great.

Furthermore, Olch[26] found that in a series of 342 women approximately fifty years of age with cancer of the breast, five times as many had a delayed menopause as compared with a series of non-cancerous women.

Taylor[27] made a preliminary report in 1939 on forty-seven prophylactic castrations in young women. His general conclusion was that 2.7 years after operation there were no more survivors than would be expected in their material. Taylor com-

pletely gave up the use of prophylactic castration following his earlier report.[28]

On the other hand, Horsley[29] is of the opinion that oophorectomy improved his results. In twenty-six cases twenty patients or 77 per cent were living and well three years postoperatively compared to 46 per cent without castration in his clinic. Horsley has recently stated that twenty-seven cases have now been done five years ago or more. Of these there have been six deaths from recurrence. There has been one death from a cause other than recurrence, this patient living five years after operation. An autopsy showed no evidence of any recurrence. Twenty patients are living, one of whom has a metastasis in the supraclavicular area. This would be 73 per cent who have gone five years or more without any evidence of recurrence.[30]

From these scanty and contradictory reports it seems that further series so treated would be of tremendous importance.

ANDROGENS AS AN ADJUNCT TO TREATMENT OF CANCER OF THE BREAST

Androgens in the form of testosterone proprionate has been used (1) therapeutically in advanced or recurrent cases and (2) prophylactically beginning at the time of radical breast operation.

The author has recently reviewed his experience with this agent on advanced breast cancer.[31] Further experience has served only to confirm the opinions previously expressed. In soft tissue involvement, such as chest wall, opposite breast, liver, lung, etc., the results in a small percentage of cases may be very gratifying for varying periods of time but probably several months at the most. In the greatest percentage of cases, however, no effect can be noted on the progression of the disease.

With metastatic bone disease no effect may be noted or the patient might have striking pain relief with recalcification of the lesion or the anomalous circumstance of clinical improvement but no roentgenographic change or even roentgenographic progression may take place. As with

soft tissue involvement, any improvement either clinical or actual is limited in time.

The usual dosage is 100 mg. three times weekly although a satisfactory response may sometimes be obtained with less. It is our belief that if one obtains a favorable response, the treatment should be continued indefinitely.

The occasional brilliant response to testosterone has led to its rather widespread use as the primary agent in treating metastatic inoperable breast cancer. In view of the variability of response and the generally satisfactory benefit from roentgen therapy it is well to emphasize that in well localized lesions, either soft tissue or bone, roentgen therapy is still the best therapeutic agent. On the other hand, in roentgen failure and in generalized disease testosterone may produce an occasional astounding result.

The first and most ardent advocate of prophylactic testosterone was Prudente.[32] He treated his first patient in April, 1939. His results after three, four and five years indicate an increase of 100 per cent compared with end results of previous years. A later communication[33] substantiated his earlier impression. The dosage of testosterone varied in Prudente's series from 25 to 175 mg. per week.

PREGNANCY FOLLOWING RADICAL BREAST OPERATION

It is generally agreed that pregnancy accelerates the growth of carcinoma already present. Westberg,[34] however, on the basis of experience in Sweden has presented a contrary point of view. Be this as it may, pregnancy subsequent to radical breast operation might light up otherwise latent metastases. The following three case reports will illustrate this possibility.

CASE I. M. B., No. 72,736, aged forty, had had a left radical breast operation in January, 1936. The patient was first seen in the Out-Patient Department at Johns Hopkins Hospital on November 4, 1936. Following the radical operation she did well until two months prior to her admission to the hospital when she observed a considerable swelling of her arm and hand. An examination showed extensive local recurrence in the chest wall and the axilla. She was also thought to have plural effusion from metastasis. The uterus was enlarged to the size of twelve weeks' pregnancy. In spite of a therapeutic abortion on November 11, 1936, death was prompt. Recurrence appearing at the onset of pregnancy and the virulent and short clinical course are suggestive of a causal relationship.

CASE II. M. G. No. 73,430, aged thirty-nine, had a radical breast operation on September 22, 1936. Pathologic examination showed medullary carcinoma without metastasis to the axilla. About January 15, 1937, she had severe pain in the back and in the right leg. She lost considerable weight and did not menstruate from the time of her discharge in 1936. She was readmitted to Johns Hopkins Hospital on February 2, 1937 following a spontaneous abortion at home. She died very soon thereafter with generalized cancinomatoses.

CASE II. H. G., No. 270,786, aged twenty-nine, had a right radical mastectomy performed by Dr. Blalock on September 1, 1942. Pathologic examination revealed comedo carcinoma with regional metastases. The patient was seen on April 4, 1944, for a routine check-up. There was no evidence of metastases or local recurrence. However, she was found to be six months' pregnant. The baby was delivered uneventfully. By August 1st there was a cough and chest pain. X-ray revealed many metastatic lesions in the ribs. She died on October 18, 1944.

Trout[35] reported two cases of pregnancy occurring four and six years, respectively, after radical mastectomy. In each instance, simultaneously with the pregnancy, carcinoma occurred in the opposite breast. Trout circularized several of his surgical friends and collected seventeen cases of pregnancy subsequent to radical mastectomy. In thirteen of these carcinoma developed in the opposite breast. Broemis[36,37] reported substantially similar results although Westberg reported several instances of pregnancy subsequent to breast surgery without untoward effect.

It is our belief, therefore, that pregnancy

subsequent to radical breast operation exposes the patient to an unnecessary risk. It is indeed an additional argument for the routine use of castration at the time of radical operation in women in the child-bearing age. At the very least, the surgeon may be expected to assume the responsibility of advising his patients against pregnancy following radical breast surgery.

PRESENT STATUS OF THERAPY FOR BREAST CANCER

On the basis of the aforementioned review it is suggested that the average individual with cancer of the breast should be subjected to immediate radical operation without preliminary irradiation. In inoperable cases or those of borderline operability irradiation, sometimes alone or combined with surgery, has much to offer including the possibility of a five-year cure.

On the basis of experience it is not possible to demonstrate any improvement in five-year end results from the routine use of postoperative prophylactic therapy.

From theoretic considerations and from a review of the literature, there is reason to believe that routine prophylactic castrations, particularly in the child-bearing age, is to be seriously considered in the routine treatment of breast cancer. Furthermore, this procedure prevents pregnancy which, in some instances at least, is associated with widespread metastasis following radical breast surgery. Androgens play an important part in otherwise hopeless breast cancer but at the present time they are to be recommended only in those cases not suitable for high voltage, roentgen therapy or in cases of roentgen failure.

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SOLITARY, unilateral cysts in women undergoing menopause that show recent increase in size are often malignant. Pavlovsky et al. recently studied 111 cases of cancer of the breast and found that in 11 per cent of them there was an associated condition of chronic cystic mastitis. (*Richard A. Leonardo, M.D.*)

OSTEOPOROSIS OF THE PELVIC BONES (ACUTE BONE ATROPHY OF SUDECK*)

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DURING the past year we have had under observation three patients with a rather unusual disease entity known previously as periostitis pubis or osteomyelitis but, in all probability, acute bone atrophy of Sudeck. It was first described affecting the pubis by Beer in 1924 and to the present time less than fifty cases have been reported in the literature. The disease occurs usually after operations upon the urinary bladder and follows a characteristic course. It is an inflammatory process of the bone beginning in the symphysis pubis and spreading via the periosteum to the pubic rami and ischia. It has no resemblance to a tuberculous or pyogenic osteomyelitis. It produces a spastic state of the adductor and perineal muscles, especially the obturator internus and levator ani. Although the cause of the condition is obscure, it does follow a definite clinical course. A clinical cure always results, with residual pain and discomfort in some cases.

Etiology. The cause of the condition is not definitely known. Various hypotheses have been advanced as to the etiologic factors involved. Beer suggested that it may be caused by retraction producing a pressure necrosis of bone. To eliminate this factor most surgeons use only lateral retraction sufficiently removed from the symphysis pubis. Pressure necrosis of bone due to suprapubic tubes was also considered. Muschat dismissed this theory as improbable since the condition developed in a case in which a small gauze wick with an oil pack alone was used. Cystotomy tubes are now popularly placed high in the bladder and, therefore, proximity of the tube to the symphysis should not be a fac-

tor. Since this can occur in simple cystotomies, pressure by means of a hemostatic bag or by packing also can be eliminated.

In a series of experiments Wheeler attempted to reproduce this disease entity. He used four sets of rabbits. In the first set he injected sterile urine under the periosteum. In the second set he injected urine infected with Staphylococcus hemolyticus aureus. In the third set he deliberately traumatized the space of Retzius and injected infected urine. He failed to reproduce the disease in any of the rabbits. Trauma to the periosteum during surgery seems to be eliminated as a cause.

Kessler, an orthopedic surgeon, described the condition fully and was of the opinion that it follows irritation or injury to the nerve supply of the bone; that is, it is a trophoneurosis.

Incidence. The condition is quite unusual. During the past twenty years less than fifty cases have been reported following suprapubic cystotomy or prostatectomy. We are inclined to believe the condition occurs more frequently than the number of reported cases would indicate. The cases were either not reported or were unrecognized or diagnosed as some other disease entity.

Beer and Wheeler have seen the condition develop after bladder operations other than prostatectomy, such as simple cystotomy. The majority of cases have occurred following suprapubic prostatectomies or at least a suprapubic operation in which the bladder has been opened.

Few cases following retropubic prostatectomy have been reported as yet in the literature. However, the authors have heard discussed by several urologists at

least six cases which have occurred follow-ing a retropubic operation. While we have no statistical data, it is our impression that this complication has been rather common considering the relatively small number of such operations that have been done in this country. A synopsis of each of two cases following a trans-urethral resection of the prostate will appear with the report of cases. Kleinberg reported a case in a fifty-three year old woman following an attack of acute pyelonephritis. No cystoscopic or blad-der manipulations were done. McGinn reported a case with typical and marked x-ray changes in a woman following a ureterolithotomy in the pelvic portion of the ureter.

Pathology. A complete study of the pathologic condition of the bone structure has not been made in any of the reported cases. Biopsy specimens of the symphysis pubis have been obtained by curettage. Muschat found microscopic evidence of a subacute osteomyelitis microscopically and, therefore, accepts the theory of bone inflammation. Wheeler, on the other hand, claims that bone sections in his cases show no inflammatory process but early atrophy. Kleinberg, an orthopedic surgeon, de-scribed pathologic disorders varying from a simple periostitis to an extensive necrosis of bone and cartilage. Pathologic progress may be spontaneously arrested in any stage and go on to complete healing and resolution. The process may, and usually does, involve the symphysis pubis and its cartilage with separation. The pubic bone and ischium frequently become involved. This lytic process is followed by healing and normal bone formation. The symphysis pubis becomes ossified and ankylosed.

Clinical Course. This condition is a definite clinical entity simulating acute bone atrophy rather than periostitis. It usually follows after a suprapubic opera-tion in which the bladder has been opened. The onset occurs anywhere from ten days to two months after the operation. It is characterized by pain over the pelvis when the patient attempts to move. The pain usually starts over the symphysis pubis and extends to the crotch and inner aspect of the thighs. It is excruciating and results in spasmodic adductor spasms.

Any type of motion produces these pain-ful spasms. There is tenderness over the pubis and ischium. Because of the tender ischial spines, sitting, use of the bed pan, defecation and even voiding is dreaded. This condition may go on for several weeks or even months before relief and improve-ment are noted.

X-ray examination discloses a mottled rarefaction of the pubis and the rami of the ischium. There is a fraying of the periosteum and pieces of bone are sepa-rated. This is due to a softening or atrophic stage in which the muscle pull at the tendinosus insertions causes the fraying. This may involve the symphysis pubis, pubi, ischial rami and ischial tuberosities. After several months the process of recal-cification begins. New bone is rapidly developed; the symphysis becomes com-pletely ankylosed. Kretschmer and Mus-chat reported that suppuration occurred in their cases. This, however, is the excep-tion to the rule. The disease is self-limited and requires three months to two years for healing.

Diagnosis. The diagnosis is made solely on the clear cut clinical picture and x-ray evidence. There are several bone diseases from which this condition must be differen-tiated. It differs from simple periostitis in that there is extensive decalcification of a large area of bone rather than a small area, such as one side of a ramus, as occurs in periostitis. There is also rarefaction of bone in Sudeck's atrophy and no cortical deposit of bone. In this condition no sequestra are produced as occurs in osteomyelitis. It is not tuberculous because it results in a complete cure. It is not Paget's disease because this produces osteoporosis and osteosclerosis simultaneously. It should not be confused with a malignant meta-static bone involvement or with osteo-myelitis of the pelvic girdle occurring

as a metastatic hematogenous pathologic change as a result of an infectious disease elsewhere in the body. A simple infection of the space of Retzius will show no bone involvement on x-ray examination.

Treatment. This disease is self-limited and does not require surgical intervention. Manipulative procedures aggravate the condition and delay recovery. Bed rest is indicated in the acute stage and activity may complicate the case. Sulfonamides and the antibiotics have been of no avail. Massage, diathermy, antispasmodics, x-ray therapy, body casts and curettage have been employed.

Goldstein and Rubin highly recommend deep roentgen therapy; they treated four patients. La Valle and Hamm employed deep x-ray therapy and diathermy in eight cases. Recovery was rapid and hospitalization, if necessary, was of brief duration.

One of our patients had a course of deep x-ray therapy and one had a course of deep x-ray therapy and diathermy treatments.

Psychotherapy is necessary for the apprehension these patients have regarding their ultimate recovery. Vitamin B by mouth and by hypodermic should be employed.

Prognosis. The prognosis is always good. These patients ultimately recover as the disease does not spread to other organs. Ossification of the symphysis pubis occurs with spur formation along the pubic rami and on the ischial bones.

CASE REPORTS

CASE I. F. S. (No. 37849), a white male, aged sixty, was admitted to the Methodist Hospital on April 8, 1947, and discharged on June 28, 1947. He complained of perineal pain, pain along the adductor muscles of the thighs and pain during defecation and urination leading to constipation and a weak urinary stream. He found all motion painful and required a cane for support. It was painful for him to sit down. Sciatica was not present. The pain had started two weeks previously and the condition had become progressively worse.

A week before he entered the hospital, at a

routine visit following a one-stage suprapubic prostatectomy performed two months previously, some pain over the symphysis pubis was present and he complained of pain on urination and defecation. At that time physical examination was negative but the patient had a residual urine of 150 cc. A recent suprapubic wound was well healed. There was marked tenderness over the symphysis pubis and especially over the ischial tuberosities. Rectal examination was negative; residual urine was 60 cc.

Past history revealed a healed pulmonary tuberculosis in 1928, coronary occlusion in 1933 and 1941 and cholelithiasis in 1942. During the previous four years he had been treated for prostatism and two months before his present hospital admission a one-stage suprapubic prostatectomy was performed. The prostate was enucleated *en masse* without difficulty. Bleeding was easily controlled by using a Wolf bag catheter, the bag being covered with one piece of oxycel gauze and inflated to 40 cc. The prostate weighed 37 Gm. and the pathologic examination revealed a benign hyperplasia. Postoperative recovery at that time was uneventful other than that the suprapubic sinus was slower than usual in closing.

Laboratory findings were as follows: The urine showed pus, 1 plus, on a basis of 1 to 4, and Bacillus coli. The red blood cell count was 4,180,000; hemoglobin, 76 per cent; and white blood cell count, 9,200. After a calcium-free diet during the height of the disease blood serum calcium was 14.2, 10.0 and 10.7 mg. per cent and the phosphorus was 5.2, 2.8 and 3.2 mg. per cent, respectively.

At the onset it was thought that the patient might be suffering from a spinal cord injury following spinal anesthesia for this prostatectomy. Neurologic examination was requested and was negative. In the interim an x-ray of the pelvis revealed the typical picture of osteoporosis of the pelvis. Treatment was symptomatic and consisted of the administration of amino acids, iron for anemia, sedation and bed rest. A high calcium diet was given. On May 27, 1947, six weeks after entrance to the hospital, a small, tender, fluctuant area developed at the lower pole of the suprapubic scar. This was incised and 10 cc. of sterile, milky fluid was obtained. This sinus tract extended upward toward the upper pole of the scar and did not dissect downward toward
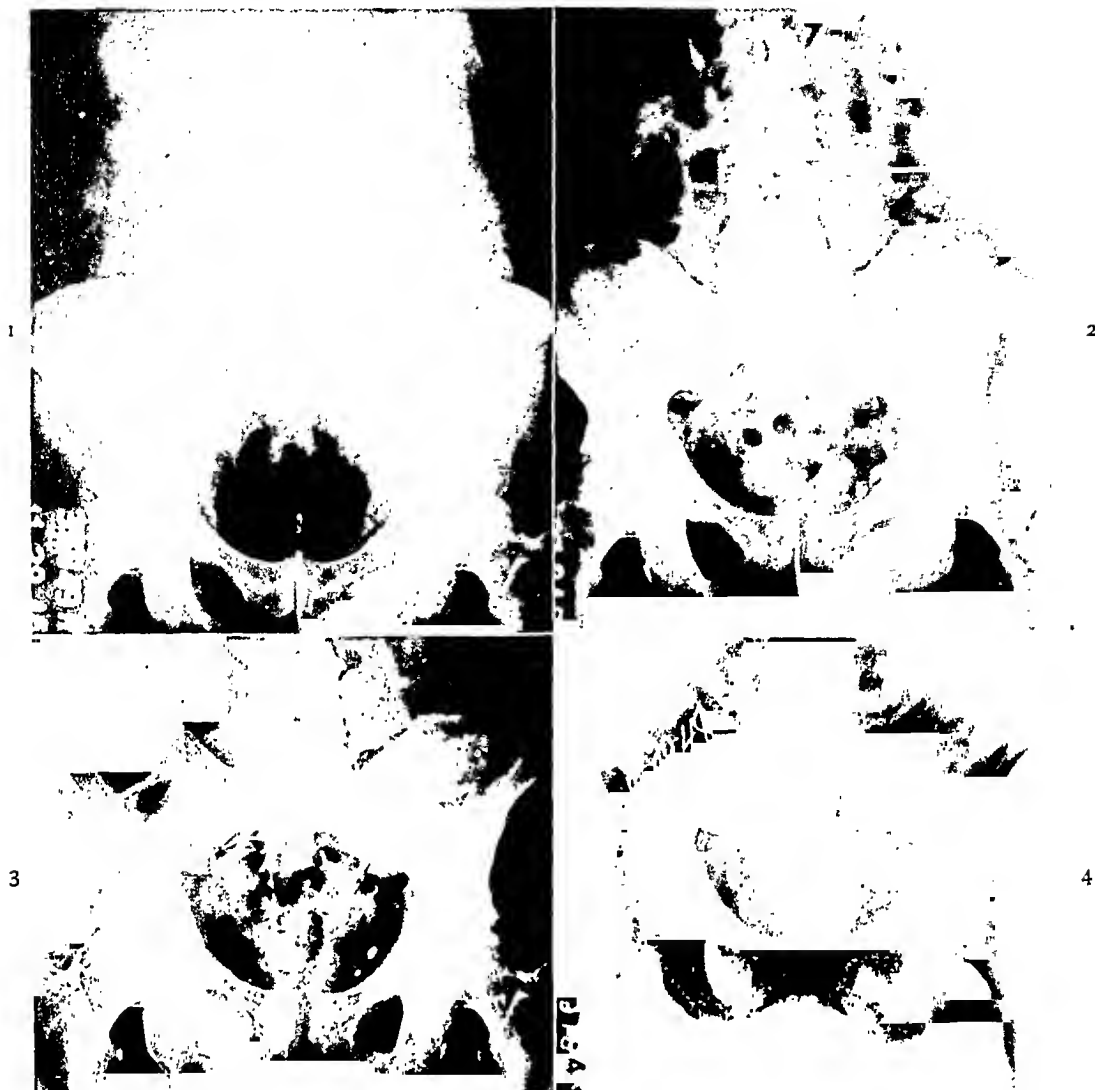
FIG. 1. Case 1, November 26, 1946. A cystogram shows the pelvic bones to be normal.

FIG. 2. Case 1, April 12, 1947, shows a patchy demineralization of both pubic and ischial bones. The inferior ramus of both pubic bones shows periosteal elevation and irregularity of the cortex. There is a definite widening of the symphysis pubis. The changes are consistent with a Sudck's atrophy of the pelvis (osteoporosis).

FIG. 3. Case 1, June 14, 1947, shows the widening of the pubic symphysis which appears slightly greater than in the previous examination. There is further irregularity and demineralization in the lower aspect of both descending pubic rami.

FIG. 4. Case 1, August 20, 1948, eighteen months postoperatively shows complete fusion of the symphysis pubis, and the ischial tuberosities show irregular spurs of new bone.

the symphysis. No further drainage occurred and the area healed within a week.

Shortly thereafter an endoscopic resection of the vesical neck was performed because of the formation of a mass of granulation tissue at 12 o'clock, resulting in persistent residual urine. This resection apparently did not hinder his recovery and resulted in a satisfactory empty-ing of the urinary bladder. His temperature throughout the hospital stay was normal. Bony tenderness began to disappear after a month.

He started walking fairly satisfactorily after five weeks.

The onset and progress of the disease in this patient probably can be best indicated by the x-rays taken at monthly intervals throughout the course of the disease. (Figures 1 to 4.)

CASE II. G. R., aged fifty-seven, was admitted on July 7, 1947, because of hemor-rhage from a peptic ulcer. He received twelve transfusions and had bilateral superficial femoral vein ligations because of phlebo-
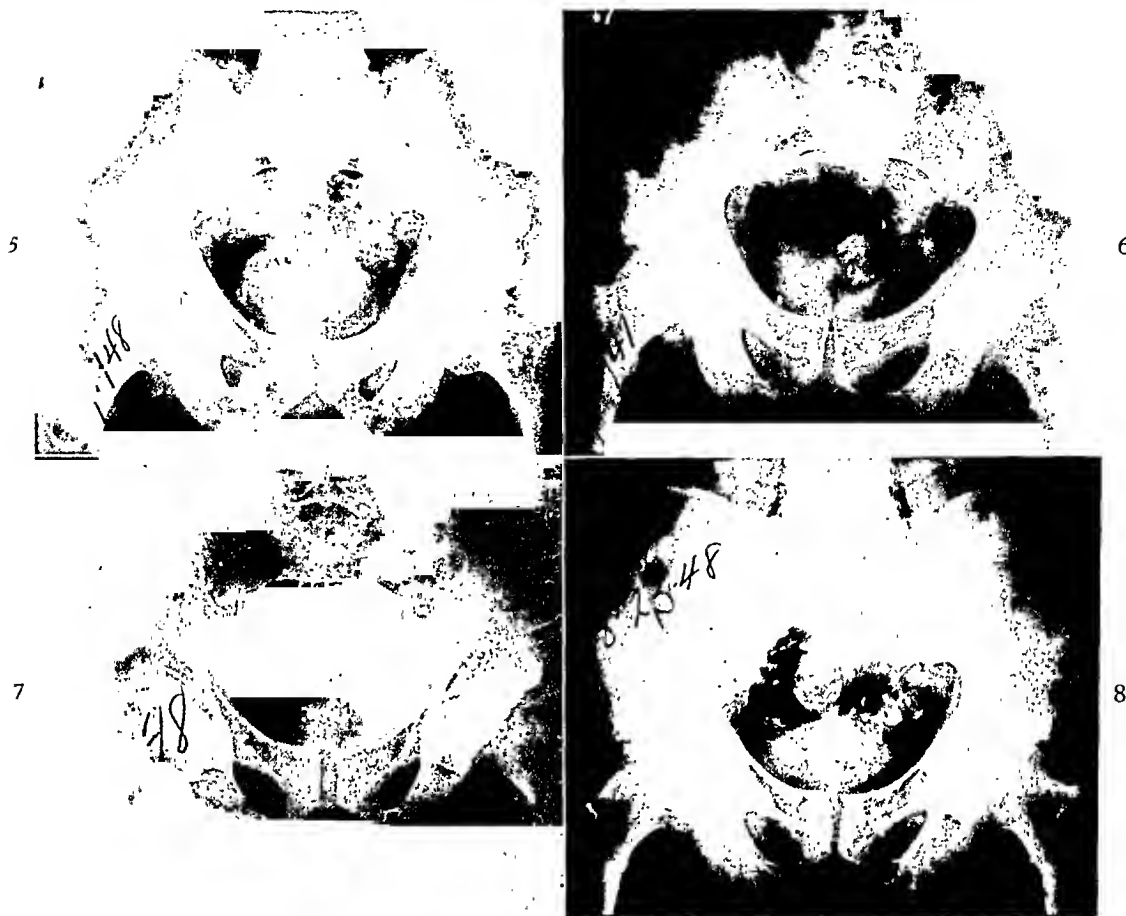
FIG. 5. Case II, December 16, 1947, six weeks postoperatively; no remarkable changes although the clinical history and physical findings are diagnostic.

FIG. 6. Case II, December 23, 1947, seven weeks postoperatively; again no remarkable changes yet in retrospect definitely diagnostic.

FIG. 7. Case II, February 3, 1948, typical changes of osteoporosis.

FIG. 8. Case II, August 23, 1948, ten months postoperatively; re-examination of the pelvis still shows some widening of the symphysis pubis and some irregularity of the ischial tuberosities. The general quality of the bone is good.

thrombosis with pulmonary infarcts. Urinary retention developed and examination disclosed a grade 2, benign type of hypertrophy. He was unable to void following several days of Foley catheter drainage. Since his general condition was such that prolonged drainage would be required, on August 4, 1947, a suprapubic cystotomy was done. On October 31, 1947, a second stage suprapubic prostatectomy was performed.

The postoperative recovery was uneventful and he was discharged on November 10, 1947. He was voiding well, there was no residual and the wound was healed.

On the day of discharge he complained of vague pains in and about the left groin and left thigh. These were assumed to be secondary to the phlebothrombosis. He was readmitted on December 6, 1947, with the typical history

and physical findings of osteoporosis. The course of the disease was followed monthly by x-ray examinations. Figures 5, 6, 7 and 8 represent definite stages in it.

He was given vitamin B complex by mouth and by hypodermic, a high caloric diet and a course of deep x-ray therapy. He received a total of 2,043 roentgen units in six treatments. Progress was slow and he developed a marked psychosis.

He was discharged on March 9, 1948. At the present time he has no symptoms relative to this complication.

CASE III. E. C. S., aged sixty-three, had a one-stage suprapubic prostatectomy performed on March 19, 1948. The prevesical space was approached for a retropubic operation. There was a rather large amount of prevesical fat and promptly a large vein was injured. The
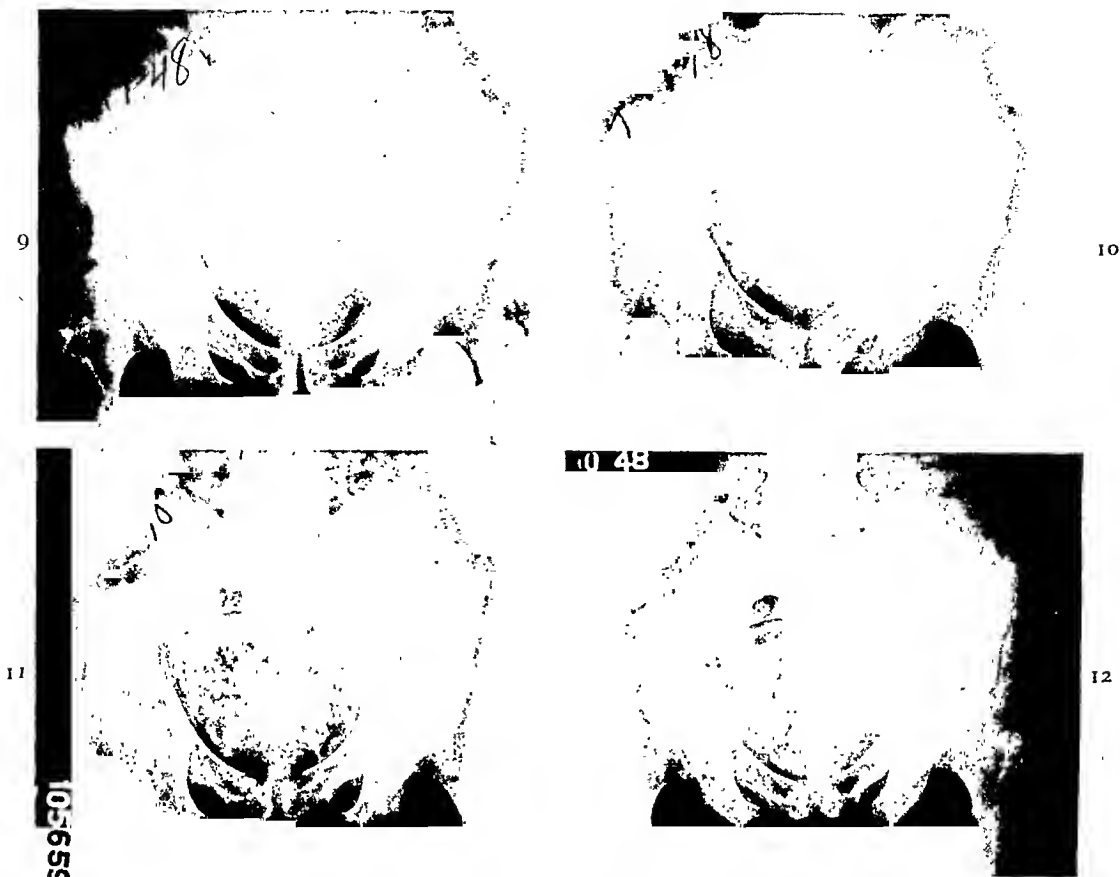
FIG. 9. Case III. X-ray examination on April 17, 1948, four weeks postoperatively; without experience this film made at this early date could be confusing.

FIG. 10. Case III, April 29, 1948, six weeks postoperatively; shows unmistakable evidence of the disease.

FIG. 11. Case III, May 6, 1948, seven weeks postoperatively; the lesions are progressive.

FIG. 12. Case III, November 30, 1948, eight months postoperatively. The film shows widening of the pubic symphysis, slightly narrower than at the previous examination one month ago. It is still very irregular and there are irregularities of both ischial tuberosities. Clinically, eight months postoperatively he had considerable discomfort when sitting especially over the right ischial tuberosity.

bleeding was controlled by a tampon of a small piece of oxycel gauze. The bladder was opened and the prostate, weighing 70 Gm., was enucleated.

A Wolf catheter, the bag covered with one piece of oxycel gauze and inflated with 30 cc. of water, was left per urethram and a No. 26 French suprapubic tube left in the bladder. The Wolf bag was gradually deflated and removed in forty-eight hours and the suprapubic tube in seventy-two hours. A 20 French Folcy catheter was inserted.

The postoperative course was uneventful except for a serosanguineous discharge that persisted for several days after urine drainage had ceased and for a low grade febrile reaction. He was discharged on April 10th, twenty-two days following operation. He noted his first symptoms of pain in the right groin and suprapubic region and pain on motion of the legs twenty-five days after the operation. Although x-rays were taken at monthly intervals throughout, Figures 9 to 12 are representative of the onset and course.

He received a high caloric diet and vitamin B by mouth and hypodermic. He was given twenty daily treatments with short wave diathermy, 2,226 roentgen units in six deep x-ray therapy treatments. His immediate recovery seemed to be faster yet approximately six months postoperatively he was a semi-invalid, experiencing great discomfort on sitting. X-ray film examinations show both improvement and extension.

From our observation of Cases II and III we are impressed with the fact that clinical symptoms *are present* in some

cases some time before x-ray changes are demonstrable. We should not wait for nor relay on x-ray evidence alone. The clinical diagnosis can be made and treatment instituted early.

The synopsis of the following case was submitted by Dr. Allen C. Bradham of Anderson, S. C.:

A forty-six year old patient with obstructive symptoms had a long series of treatments with no relief. Cystoscopy disclosed a well defined median bar. A transurethral resection was done on January 26, 1943. Six Gm. of tissue were removed. Bleeding was troublesome at the time of operation and subsequently for which a Foley catheter was used with intermittent traction. Pathologic examination of the tissue revealed benign prostatic hyperplasia.

On the tenth postoperative day he began to complain of "neuritic" pains in his perineum, thighs and lower back with adductor muscle spasms and incoordination of gait because of pain. The symptoms persisted in spite of various medications and on May 17, 1943, x-ray examination of the pelvis revealed a peculiar "moth-eaten" appearance of the pubic and ischial bones which the roentgenologist suggested looked like syphilis. His serology was negative. He was examined in an eastern clinic. Metastatic malignancy was suspected but no definite diagnosis was made. The last x-ray examination in December, 1943, revealed punched-out areas in the pubic and ischial bones but he was symptom-free. In January, 1948, the patient was clinically well.

The data on the following case were supplied by Dr. B. Weems Turner of Houston, Texas:

V. C. S., No. 14929, had prostatic hypertrophy, grade 2 plus. There was a previous history of gallbladder infection, pyelonephritis and some rheumatism. A transurethral prostatectomy and bilateral vasectomy were performed on November 20, 1944, and again on June 9, 1945, because of some encroachment of prostatic tissue at the compressor muscle. There was considerable bleeding anteriorly. More coagulation than usual was carried on. Ten days after surgery the patient complained of severe pain in the adductor muscle of the thigh, in the suprapubic region, and in the rectum and perineum. The symptoms con-

tinued and increased. X-ray examination during the third week revealed a rarefying osteitis of the symphysis with separation. In six weeks there was a separation of ¾ of an inch. The symptoms remained stationary for a period of three months. The suprapubic pain and the pain in the adductor muscle subsided. The frequency of urination continued with pain on urination and in the rectum. At the end of the year the lesion of the symphysis was practically filled in. The rectal pain and frequency of urination continued.

The patient in January, 1948, had many arthritic symptoms with some frequency of urination and rectal pain. He can walk or lie down comfortably but sitting or riding aggravates the pain.

Dr. E. J. McGinn of the Marshfield Clinic, Marshfield, Wisconsin, submitted the following case:

The patient was a white female aged fifty-five. She had a stone 10 by 15 mm. impacted in the lower end of the left ureter. Cystoscopic manipulation was attempted on two different occasions with no success. The stone was removed by an uncomplicated ureterolithotomy. A ureterostomy tube was left in place for about ten days and, when this was withdrawn, the wound healed promptly. Symptoms of osteitis appeared about six weeks after her dismissal from the hospital. X-ray examinations over a long period showed the typical changes of osteoporosis. In the healing phase complete ossification of the symphysis pubis occurred.

COMMENT

Within a year we have observed three instances of this complication; we had never observed one previously. Certainly one could hardly fail to overlook this complication since the patient is totally incapacitated and the psychic trauma is quite marked.

Having observed with our colleagues cases of Sudeck's atrophy in the long bones following trauma and because of the clinical course and x-ray findings, we are inclined to agree with Wheeler that the condition is an acute bone atrophy. Residual symptoms may persist for months or years.

In our hands there has been no change in the technic of the operation of suprapubic prostatectomy, except for the use of one piece of oxycel gauze over the bag of the Wolf or Foley catheter, the use of smaller catheters and tubes and earlier removal of the suprapubic tube which has resulted in more rapid closure of the wounds. The bladder is routinely sutured to the anterior abdominal wall during the enucleation.

We begin our enucleation anteriorly. However, we are very careful to break through the mucosa at the vesical margin. In those cases of simple lateral lobe hypertrophy the enucleation may be started in the midline posteriorly.

Since the three cases occurred in our practice within a year, we question the possible relation of the use of hemostatic agents as contributing factors.

Our results from the use of x-ray therapy alone in one case and from x-ray therapy and diathermy in another case were disappointing. So few cases have been treated by one or both methods that we could find no recommended dosage schedule. We took the average x-ray dosage of the cases reported by Goldstein and Rubin and were of the opinion that should we observe another case, we would probably request that the patient have more treatments. Similarly, no definite schedule for diathermy treatments has been established and it may be that additional benefit or more immediate relief might be obtained from treatments given two or three times daily.

Drugs given for relief of muscle spasm should be beneficial whether it is prostigmine and atropine, as advocated by Rosenberg and Vest, curare or similar drugs such as are used for the muscle spasm of poliomyelitis.

SUMMARY

We have discussed acute bone atrophy of Sudeck involving the pelvic bones and have reported additional cases. That it is an osteoporosis or atrophy is evidenced by the x-ray findings and clinical picture. It should not be called periostitis or osteomyelitis pubis. It is a definite clinical entity, is self-limited, requires no surgical intervention and ultimately results in a clinical cure.*

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*Since the submission of this manuscript for publication five additional cases of osteitis pubis have been reported; two following a retropubic prostatectomy, two following a two-stage suprapubic prostatectomy and one following an abdominoperineal resection for carcinoma of the rectum. (ABRAMS, M., SEDLEZKY, I. and STEARNS, D. B. Osteitis pubis. *New England J. Med.*, vol. 240, 1949.)

CLINICAL MANAGEMENT OF LUNG ABSCESS

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THE severity of lung abscess has not materially lessened despite the advent of chemotherapeutic agents and penicillin. In the management of the condition some clinics continue to manifest an apparent discrepancy of opinion as to which patients shall receive medical therapy and which are to be subjected to surgery. Moreover, opinions vary as to which type of procedure to employ in the latter group. In reporting our series of patients we believe that one can lay down a specific plan of management. It must be emphasized, however, that there be complete cooperation between the internist and surgeon and neither form of treatment should be prejudicial.

Etiology. Both from experimental as well as from clinical evidence, abscesses originate chiefly from three mechanisms: (1) bronchial occlusion, (2) septic embolism and (3) direct lymphatic extension. We are convinced that the latter two are so infrequent clinically that they lose importance in our consideration. The chief offender, by far, is bronchial obstruction. This may be evidenced in many ways. A septic temperature curve aside from that produced by trapped pus is often conspicuous. Roentgenographically, it may be portrayed by a fluid level in the cavity; bronchoscopically, it may often actually be seen.

In considering causes of bronchial obstruction two factors are paramount: (1) the nature of the infecting organism and (2) the type of lesion preceding the abscess. Many organisms may be isolated from the flora of a lung abscess, and we do not believe that it is any particular variety in a large group of patients. A mixed flora in a region of the lung which is not bacteriostatically prepared for the invasion results in bronchial obstruction. This obstruction is mainly in the form of bronchial edema. Obstruction may not necessarily be complete and is usually not so. Inadequate drainage from the lung distal to the edema sets up a vicious cycle wherein organisms and débris constantly bathe the efferent bronchus. The underlying pulmonary lesion in the majority of instances is a pneumonitis. In the series reported by Cutler and Gross twenty-three out of ninety patients presented some type of pneumonia. Of lesser importance are bronchiectasis, bronchostenosis and foreign bodies, all of which may cause bronchial obstruction. Previous reports have emphasized the last named in post-tonsillectomy groups in which mucus and blood have been aspirated. Again, one must not lose sight of a group caused by the obstruction produced by a bronchogenic carcinoma.

Clinical Management. Patients when first seen are given a complete evaluation with regards to toxicity in the temperature curve, blood picture, amount and ease of raising sputum and bacteriological studies. Complete x-rays are done for localization. Subsequent studies are done weekly with particular attention to progress of the lesion but may be repeated sooner if obstruction is suspected. Potter-Bucky films are of frequent value in this regard. If at any time there is evidence of obstruction to drainage by the natural bronchial route, the regimen of medical treatment comes to an end and surgical measures are adopted. Evidences of bronchial obstruction, previously mentioned, are those of (1) reduction in the amount of sputum without corresponding reduction in febrile course, (2) roentgen evidence of increase in the cavity size, presence of a fluid level or evidence of intracavitary tension. In

fact, we look more to continued improvement in the status of the abscess rather than cessation of improvement or unfavorable progress. The abscess must drain constantly and its purulent products find exit through the bronchial route if medical treatment is considered effective. Any failure of spontaneous drainage calls for surgical drainage either by bronchoscopy or by the external route. This is a sound surgical principle for the treatment of pus anywhere in the body.

Bronchial obstruction is treated by bronchoscopy for at least one trial. If unsuccessful, it is not repeated. There are other advantages of bronchoscopy which have been enumerated by others. If a foreign body is present, it can be diagnosed and possibly removed; if a tumor is present, it is best known early as it will influence the end result and type of treatment. Bronchoscopy is also valuable in localizing the abscess.

Exceptions to the watchful-waiting policy exist in cases of empyema. This we classify as a surgical emergency, and no attempt is made to delay surgical drainage of the empyema even by bronchoscopy. Needless to say, this includes any evidence of rupture of an abscess into the pericardium or other contiguous non-pulmonary structures.

During the period of conservative treatment no attempt is made to needle the abscess. This method of treatment, although reportedly effective by some authors, is to be condemned. One of our patients came to us with tension pneumothorax, empyema and a resultant bronchial fistula following a cavity needling with instillation of penicillin.

Severe hemorrhage will influence the choice for surgery, frequently sooner than desirable. However, one has no way of knowing whether a hemorrhage may be fatal and the desire to continue conservative therapy may soon be outweighed by the fear of a terminal hemoptysis. When hemorrhage has appeared as the outstanding symptom and in large amounts, we have elected to subject the patient to surgery. We believe this type of case constitutes one of the most serious problems that can confront us in our choice of one method of treatment over another.

Type of Surgical Procedure. Many writers have stipulated a six weeks' watchful-waiting policy before electing surgery. We do not believe one can set any time limit on observation. Many of our cases called for surgical intervention long before this time, and it would appear that complications occur much sooner in some than in others.

Our criteria for drainage exist in utilizing this procedure when most of the lobe can be salvaged for future use. It is also useful in preparing patients for lobectomy when sufficient pneumonitis still exists to increase the hazard of resection. On the other hand, it is useless to drain a lobe which has multiple abscesses to the extent that the entire lobe is involved. Likewise, it would seem foolhardy to drain an abscess when the lobe is the seat of widespread bronchiectasis, or if there is a fibrous bronchial stenosis or possibly a tumor. It may not always be possible to have evidence of other underlying disease at hand when drainage becomes imminent. In such cases secondary resection must necessarily follow. Our failure to remove diseased lobes has been due to ignorance that such concomittant disorder existed at the time of primary surgical treatment. To recapitulate, when lobectomy would appear to remove a large portion of normal pulmonary tissue in eradicating the abscess, drainage is preferable and will leave the patient a good functioning lobe unless there is another underlying pathologic condition. We recall a case of severe hemorrhage which was localized to the dorsal segment of the lower lobe and on whom decision was made to perform lobectomy. At exploration the abscess was found to invade the upper lobe as well, but it was so small that we hesitated to perform pneumonectomy and remove so large a portion of viable lung. The thorax

was re-expanded and external drainage substituted with excellent results.

There is no need to dwell on advances in technic of the past few years. We must emphasize, however, that accurate localization is imperative both for drainage and resection. The use of the bronchoscope and adequate roentgen studies have enhanced this localization.

Secondary Surgical Procedures. Although many abscesses resolve by one method of treatment or another, many will continue to present symptoms of cough and sputum. When this occurs, bronchograms are made to determine the nature of the lesion; and if bronchoscopy has not been performed, this is done. This type of investigation has revealed bronchiectasis in all instances in which it was suspected. Such patients are advised to undergo secondary lobectomy unless bronchospirometric studies would indicate that their disease is too extensive.

Bronchial fistula has been encountered in numerous instances. The fistula is given adequate opportunity to close spontaneously. Films with lipiodol introduced into the track may reveal the cause of failure in the nature of a small pocket along the track. If persistence of fistula occurs, surgical attempts at closure are made. Space does not permit a discussion of technical aspects of this closure, but one may elect to make a second attempt if the primary closure was unsuccessful. All of our primary closures except one were effective and the latter responded to a secondary operation. Muscle or pleural grafts are used. Failure of fistula closure may call for lobectomy as there may be sufficient evidence of bronchiectasis in the communicating bronchus to justify it.

Patients presenting empyema as a primary or secondary complication may be confronted with residual pleural pocketing. Such pleural spaces are subjected to vigorous trials of suction re-expansion. If this fails, these patients are subjected to decortication and re-expansion in combination with a certain amount of unroofing.

Frequently, such a patient will present a bronchial fistula which must be sutured at the time of decortication if the latter is to be successful in obliterating the space.

Results. This report comprises an analysis of sixty-six consecutive cases of lung abscess treated from 1939 through 1946. Careful study was made of each case and an opportunity prevailed to use medical or surgical therapy, whichever was indicated. Table 1 shows the location of the abscess with regard to type of treatment used. Although there were no deaths in this group, we do not believe the rationale is infallible, as none of these cases presented fatal complications, for example, brain abscess. It would seem, however, that we have arrived at a definite mode of treatment for these cases with an outlook for good results.

Two of these patients had purely medical treatment consisting of chemotherapy and postural drainage. Both patients responded without complication; and although the sputum was foul in both cases, they apparently fall under the classification of the non-putrid type.

Relief of bronchial obstruction by bronchoscopy alone was successful in thirty-three of our sixty-six cases. It was curative in only twenty-five of these. Of the eight remaining although relieved of their pulmonary abscesses, four still had varying degrees of bronchostenosis and four exhibited bronchiectasis. Either of these conditions can lead to further episodes of abscess formation and consequently demand lobectomy for permanent cure.

Open drainage was elected in fourteen of our sixty-six cases. All of these had bronchoscopic trials with failure. Election of drainage over resection was on the basis of salvaging remaining lung tissue. Of these fourteen permanent cures resulted in twelve. The other two had bronchocutaneous fistula and bronchiectasis remaining, respectively. Consequent lobectomy will be necessary in both of these unless surgical closure of the fistula in the former is successful. Only eight of these

fourteen cases were uncomplicated for there were two secondary abscesses, two cases of empyema and one other fistula which required further definitive treatment.

Little need be said about the seven

complications incident to treatment should be enumerated. Of the various methods of treatment those presenting empyema primarily showed 50 per cent complications; those with surgical drainage showed 43.5 per cent complications; those with bron-

TABLE I
LOCATION OF ABSCESSES

	Medical Rx	Broncho-scopy	Surgical Drainage	Empyema Drainage	Lobectomy
Left upper	..	4	2	1	1
Lingula, left upper	..	1	1	0	0
Left lower, dorsal branch	..	2	1	2	0
Left lower, branch bronchi	1	2	1	3	2
Right upper	1	4	8	0	0
Right middle	..	5	0	1	1
Right lower, dorsal branch	..	6	1	0	0
Right lower, branch bronchi	..	7	0	3	1
Right middle and lower	..	1	0	0	1
Entire right lung	..	1	0	0	1

patients subjected to lobectomy. All were sufficiently advanced to deserve complete extirpation. The indications were bronchiectasis in two, multiple abscess formation in four and severe hemorrhage in one. Resultant cures were apparent in all but one who developed a secondary abscess in the remaining ipsilateral lobe. This is now chronic but the patient refuses further treatment.

There is a noteworthy group of cases who present empyema when first seen. This severe complication occurred in ten of our cases. They all required surgical drainage of the empyema *per se* prior to drainage of the abscess. In most cases the abscess cleared promptly as it possessed adequate drainage into the pleural cavity. Complications were frequent in this group. Five developed fistulas in four of whom surgical closure was effective. Two required unroofing operations for remaining pleural pocketing; one of these required a secondary lobectomy. Out of the entire group one alone remains complicated, however, with a bronchocutaneous fistula. (Table I.)

On closer analysis the percentage of

choscopy 24.2 per cent; and those with lobectomy 14.3 per cent. This may not be a fair statement for comparison of therapy as it does not take into consideration the severity of bronchial obstruction in varying types of flora, a flexible and immeasurable finding. It does, however, give some insight as to what one can expect in various methods of treatment in the attempt to attain survivals.

SUMMARY

1. Bronchial obstruction is the main underlying factor in the determination of progress and treatment in lung abscesses. Most patients exhibit pneumonitis previous to abscess formation, and the virulence of the organisms determine the amount of bronchial inflammation.

2. A period of observation is advocated for each case during which conservative measures are adopted. When cessation of improvement is noted, as evidenced by inadequate bronchial drainage, conservative therapy ceases.

3. Patients are usually bronchoscoped prior to instituting other surgical treat-

ment. If this fails, bronchoscopy is not repeated.

4. Surgical drainage is used in those patients in whom sufficient pulmonary tissue can be salvaged for future use.

5. Lobectomy is advocated when the underlying pathologic process has involved the major portion of a segment of lung.

6. Immediate surgical pleural drainage is utilized in cases presenting empyema as a complication of conservative management.

7. A group of sixty-six cases is analyzed wherein two patients received conservative therapy, thirty-three bronchoscopic treatment, fourteen surgical drainage for the abscess, ten surgical drainage for empyema and seven lobectomy. The percentage of complications incident to treatment is analyzed and, with no mortality, would seem to indicate a basis for treatment of future cases.

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SURVEY OF THE VALUE OF NEUROSURGICAL
TREATMENT FOR THE RELIEF OF INTRACTABLE PAIN*

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THERE are many neurosurgical procedures of proven value for intractable pain. For example, alcohol injection or section of the posterior roots of the trigeminal nerve in tic douloureux are

Fig. 1. Diagrammatic representation of pain pathways from periphery to cerebral cortex showing neurosurgical procedures used at various levels.

accepted procedures. Glossopharyngeal neuralgia, an uncommon syndrome, has been relieved by intracranial section of the ninth nerve, and the pain of geniculate ganglion neuralgia or the Ramsey-Hunt syndrome has been reported by Furlow relieved by intracranial section of the nervus intermedius.[1] Pain about the temporal artery which may be caused by

"temporal arteritis," migraine or abnormal pulsation of the artery can be relieved in certain cases by ligation or resection of this vessel. The pain of atypical vascular neuralgia has not as yet responded to a specific neurosurgical procedure.

This paper is limited to the following conditions causing intractable pain: (Group i) malignancies; (Group ii) intractable pain associated with involvement of blood vessels; (Group iii) miscellaneous including herpes zoster, tuberculosis of the bladder, arachnoiditis and compression fracture; (Group iv) pain of unknown etiology associated with neurosis.

The minor procedures used for the relief of intractable pain (Fig. 1) were: (1) injections with novocain, absolute alcohol or thiamine chloride; (2) neurotomy and (3) ligation or resection of the temporal artery. The major neurosurgical procedures consisted of (1) rhizotomy; (2) spinothalamic tractotomy; (3) myelotomy; (4) ablation of part of sensory cortex and (5) prefrontal lobotomy. Operations on the sympathetic nervous system for causalgia, cardiac and vascular pain consisted of (1) cervicothoracic sympathectomy, (2) thoracic sympathectomy, ramisectomy and ventral and dorsal rhizotomy and (3) lumbar sympathectomy.

Although this paper describes major neurosurgical procedures mainly, it must be added that neurotomy is of value in tic douloureux, occipital neuralgia and gangrene. Its use is limited since only a few peripheral nerves are purely sensory and section of mixed nerves would lead to motor loss.

Injection of absolute alcohol has a wider

use and many proponents.[5—20] It is of greatest value in trigeminal neuralgia. Mandl[2] and Swetlow[3] first proposed paravertebral alcohol block for cardiac pain. White perfected its technic for the treatment of angina pectoris.[4] His results and

nal (seven cases) and pelvic malignancies (thirteen cases) there were no deaths due to the operation although only two patients were in good condition before surgery.

The advantages and disadvantages of alcohol versus chordotomy for pain of low

TABLE I

COMPARISON OF ADVANTAGES AND DISADVANTAGES OF SUBARACHNOID INJECTION OF ALCOHOL VERSUS CHORDOTOMY FOR RELIEF OF INTRACTABLE PAIN CAUSED BY LOW ABDOMINAL AND PELVIC MALIGNANCIES

	Alcohol	Chordotomy
Type of procedure	Injection	Operation
Mortality	None	None in our series
Relief of pain	Unpredictable; occasionally pain is aggravated; multiple injections often necessary for temporary relief of pain	Immediate and complete in all cases of our series
Bladder dysfunction	Most frequent complication	Temporary (18%); permanent (12%); our series
Motor weakness	Partial and unilateral occasionally	Temporary 20%; permanent 6%; our series
Skin anesthesia	May be complete for all forms of sensation in roots injected and often very annoying to patient	Only for pain and temperature; touch not affected, often complains of chest and incisional pain (18%) in our series

those obtained by rhizotomy or sympathectomy are discussed in the section dealing with intractable pain caused by cardiac lesions.

Since Dogliotti's original contribution[20] in 1931 in which he reported forty-five cases of intractable pain treated by subarachnoid absolute alcohol, many articles[5—20] have been published on its use. The danger of producing a transverse lesion of the spinal cord contraindicates the injection above the first lumbar vertebra. Consequently its greatest use has been for the relief of intractable pain caused by malignancies in the lower abdomen and pelvis. It is in this group that unilateral or bilateral chordotomy offers the best results. The problem is therefore: When is alcohol or chordotomy indicated?

Alcohol is preferred when life expectancy is less than three months or the patient is a poor operative risk. When life expectancy is greater than three months, chordotomy seems to us the operation of choice. In our series of twenty cases of low gastrointesti-

abdominal and pelvic malignancies can be compared by referring to Table 1 and Figure 2.

The first intraspinal rhizotomy was done by Abbe[21] in 1888 for relief of pain associated with athetosis. Section of the spinothalamic tract in the spinal cord for the relief of intractable pain (chordotomy) was first proposed by Schuller (1910) and first performed by Martin in 1911. It was soon realized that this tract had to be sectioned above the level of the sixth thoracic segment (usually first to third) to get satisfactory relief of pain below the umbilicus.

Foerster and Gagel[22] were the first to show that the pain fibers for the lower extremities and the sacrum were lateral in the tract while those for the thorax and upper extremities were mesial. Kahn and Barney[23] suggested for the maximal relief of tabetic crises that the incision be carried at least three mm. mesial to the emergence of the anterior roots. Recently, Hyndman and Van Epps[24] again empha-
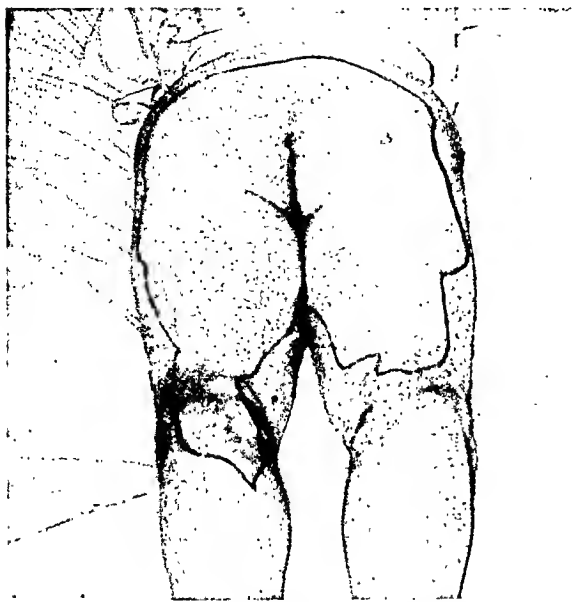
Fig. 2. Pain due to carcinoma of rectum relieved by subarachnoid injection of alcohol, resulting in complete anesthesia in buttocks and genitalia more annoying than original pain.

sized the importance of the mesial extension of the incision. They suggested that the sphinothalamic tract runs in the most ventral portion of the cord and that a section here will give loss of pain and temperature in the thoracic and high abdominal areas without effecting these modalities below this level. To the best of our knowledge no other investigators have confirmed their observations. Intractable pain in the high thorax, upper extremity or supraclavicular areas obviously cannot be relieved by a section made at the level of the first thoracic segment.

Grant,[37] Stooky,[25] Peet[30] and others have found that incisions made at the cervical level did not relieve pain in the majority of cases. A disadvantage to the cervical cord incision is the danger of injury to the innervation of the diaphragm particularly in bilateral section. The inadequacy of cervical cord section has led to incisions into the spinothalamic tract at higher levels (Fig. 1): in the medulla as advocated by Schwartz and O'Leary[27] and White,[28] and at the junction of the pons and mesencephalon as first done by Dogliotti[29] and later by Walker and others.[30]

Although sections made at the above levels can give adequate relief of pain, the technical factors involved make these procedures difficult. Moreover, there may be secondary disabling symptoms due to injury of adjacent structures. It is our impression that the procedures at these levels will be abandoned. One could theorize that placing a silver clip on the posterior inferior cerebellar artery might give a more certain result as far as complete loss of pain and temperature is concerned on the contralateral side of the body; the complications of course might be greater.

The disadvantages of the medullary and mesencephalic procedures have coaxed the neurosurgeons into higher levels and has led to the excision of sensory cortex with favorable results in some cases as reported by Mahoney[31] and Horrax.[32] This procedure also has its disadvantages. A craniotomy must be done, sufficient cortex must be removed and Jacksonian convulsions may occur.

Van Wagenen,[33] Freeman and Watts[34] and Poppen[35] have shown that intractable pain can be relieved in certain cases by prefrontal lobotomy. The pain is still present but the patient's reaction to it is passive. This procedure has great possibilities but there are also many disadvantages. It should not be used in a person with normal mentality and intractable pain caused by a non-malignant condition such as phantom pain following amputation, angina pectoris, tabetic crises, etc.

As Freeman and Watts first pointed out, this is the procedure to use when a psychotic or a severe psychoneurotic patient develops intractable pain due to malignancy. The operation also has possibilities in severe pain with narcotic addiction or severe neurosis, central or thalamic pain, and perhaps intractable pain of herpes zoster.

We are reporting the results in fifty-seven cases of intractable pain subjected to various neurosurgical procedures. These cases were subdivided into groups as shown in Tables II, III, IV and V.

TABLE II

RESULTS FOLLOWING NEUROSURGICAL PROCEDURES FOR RELIEF OF INTRACTABLE PAIN CAUSED BY MALIGNANT TUMORS (GROUP I)

Cause of Pain	Condition of Patient			Operation	Immediate Relief of Pain			Late Relief of Pain			Mortality within 14 Days Postop.	Interval between Operation and Death or Follow-up	
	Good	Fair	Poor		Comp.	Part.	None	Comp.	Part.	None		Death	Follow-up
Nasopharynx —3	..	..	3	Rhizot. Cr. 5 and 9; Cerv. (1–3) —2	..	1	..	..	1	..	1	24 hr.	5 mo. (D)
				Rhiz. Bilat. Cr. N. 9; Cerv. (1–3) —1	1	..	..	1	..	..	0	4 wk.	
Paravertebral —7	..	1	6	Rhizot. unilateral —2	2	..	..	..	2	..	0	......	5 wk.; 7 mo.
				Rhizot. bilateral —1	1	..	..	1	..	..	0	3 wk.	
				Rhiz. and chordotomy —2	1	..	..	1	..	..	1	12 days	
				Spinothalamic tract medulla —2	..	..	..	..	..	..	2	24 hr.	
Gastrointestinal—7	..	1	6	Chordotomy unilateral —2	2	..	..	2	..	..	0	5 wk.	5 mo.
				Chordotomy bilateral —4	4	..	..	4	..	..	0	18 days	1 mo.3 (D)
				Rhizotomy unilateral —1	..	1	..	..	1	..	0	......	3 mo. (D)
Pelvic —13	2	5	6	Chordotomy bilateral —11	11	..	..	11	..	..	0	3 and 6 wk.	6 wk. (2) 1 mo. (4) 2 mo. (3) 9 mo.; 2 mo.
Skeletal —3	..	1	2	Rhizotomy bilateral —2	1	1	..	..	1	1	0		
				Chordotomy bilateral —1	1	..	..	1	..	..	0	1 mo.	
				Rhizotomy bilateral —1	1	..	..	1	..	..	0	......	1 mo.
				Spino-th. tract mesencephalic —1	1	..	..	1	..	..	0	......	3 mo.
Total —33	2	8	23	33	26	3	0	23	5	1	4 (12%)		

TABLE III

RESULTS FOLLOWING NEUROSURGICAL PROCEDURES FOR RELIEF OF INTRACTABLE PAIN (VASCULAR GROUPS)

Cause of Pain	Condition of Patient			Operation		Immediate Relief of Pain			Late Relief of Pain			Mortality within 14 Days Postop.	Interval between Operation and Death or Follow-up	
	Good	Fair	Poor			Comp.	Part.	None	Comp.	Part.	None		Death	Follow-up
Group II: Causalgia —5	4	1	..	Sympathectomy (T2, T2)	3	3	..	..	3	..	..	0	..	6, 12, 18 mo.
				Periarterial sympath. (Femoral) and chordotomy	1	..	1	..	..	1	..	0	..	5 yr.
				Periarterial sympath. (Brachial) and extensive rhizot. Cervical 5 to thoracic 4 incl.	1	..	..	1	..	..	1	0	..	5 yr.
Group III: Cerebrospinal syphilis —4	2	..	2	Chordotomy bilateral	3	..	1	2	..	1	2	0	..	2 yr.; 3 yr.
				Rhizotomy bilateral	1	..	..	1	..	..	1	0	..	2 yr.; (D)
Group IV: Cardiac —3	1	1	1	Rhizot. bilat. C8–T8 incl.	2	2	..	..	2	..	..	0	..	4 (D) and 8 mo. (D)
				Rhizot. unilat. T1–T7 incl.	1	1	..	..	1	..	..	0	..	3 mo. (D)
Group V. Vascular occlusive disease —2	..	..	..	Chordotomy bilateral	1	1	..	..	1	..	..	0	..	2½ yr.
				Chordotomy unilateral	1	1	..	..	1	..	..	0	..	3 yr.
Total —14	..	..	..		14	..	..	..	..	..	..	0		

INTRACTABLE PAIN DUE TO MALIGNANCY

Nasopharyngeal. There were three cases, all carcinomas. The duration of pain was six months, twelve months and seven years, respectively. All the patients were in poor physical condition before operation

two cervical roots. The third patient had bilateral section of the ninth and upper three cervical roots.

The first patient died twenty-four hours after operation and the results could not be evaluated. The second had partial

TABLE IV
RESULTS FOLLOWING NEUROSURGICAL PROCEDURES FOR RELIEF OF INTRACTABLE PAIN
(MISCELLANEOUS GROUP)

Cause of Pain	Condition of Patient			Operation	Immediate Relief of Pain			Late Relief of Pain			Mortality within 14 Days Postop.	Interval between Operation and Death or Follow-up	
	Good	Fair	Poor		Comp.	Part	None	Comp.	Part	None		Death	Follow-up
Group VI: Miscellaneous													
Arachnoiditis —1	1	..	..	Rhizotomy bilateral —1	..	1	..	..	1	..	0	......	3½ yr.
T. B. bladder —1	..	..	1	Chordot. bilateral —1	1	..	..	1	..	..	0	18 mo.	
Herpes (face) —1	..	1	..	Rhizotomy 5th C.R.N. —1	..	1	..	..	..	1	0	......	1 yr.
Fract. th. 12 with paraplegia —1	..	..	1	Chordotomy —1	..	1	..	..	1	..	0		
Total: —4	..	..	..		4	..	.	..	..	..	0	2 mo.	

TABLE V
RESULTS FOLLOWING NEUROSURGICAL PROCEDURES FOR RELIEF OF INTRACTABLE PAIN OF UNKNOWN ETIOLOGY WITH NEUROSIS

Cause of Pain	Condition of Patient			Operation	Immediate Relief of Pain			Late Relief of Pain			Mortality within 14 Days Postop.	Interval between Operation and Death or Follow-up	
	Good	Fair	Poor		Comp.	Part	None	Comp	Part	None		Death	Follow-up
Group VII: Etiology unknown with neurosis—6	3	2	1	Chordotomy unilateral Lumbar laminect. (3) Paravertebral block	1	..	1	..	..	1	0	..	2 yr.
				Sympathectomy (lumb.) Subarachnoid alcohol Chordotomy unilateral (3)	1	..	1	..	..	1	0	..	2 yr.
				Paravertebral block Rhizotomy unilateral Lumbar laminect. (3)	1	..	1	..	..	1	0	..	2½ yr.
				Paravert. alcohol Chordotomy unilat. (3)	1	..	1	..	..	1	0	..	2 yr.
				Rhizotomy bilateral	1	.	1	..	..	1	0	..	3 yr.
				Rhizotomy unilateral	1	..	1	..	..	1	0	..	3 yr.
Total: —6	..	..	..		6	..	..	..	..	..	0		

and had received radium, x-ray and narcotics.

One patient had intracranial section of the fifth and ninth nerves and the upper three cervical roots. One had intracranial section of the descending root of the fifth and ninth cranial nerves and the upper

relief and died five months later; the third had complete relief of pain and died four weeks after operation. The results of this small group were poor.

Temple Fay was the first to report the combined section of the glossopharyngeal and upper cervical roots for the relief of
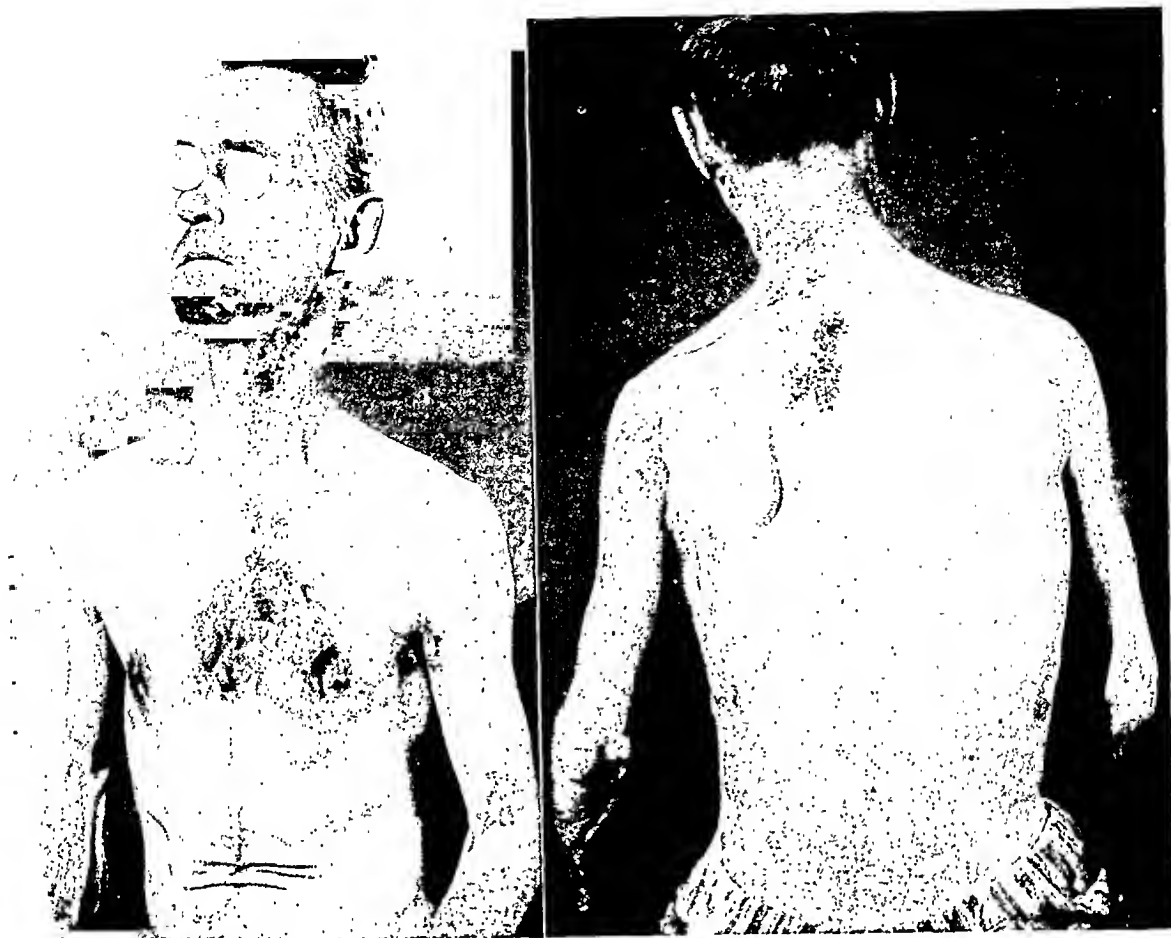
FIG. 3. Intractable pain due to a paravertebral neoplasm in the left upper thorax. Note abnormal sweating of face and upper thorax on involved side. Patient relieved by a rhizotomy from C_8 to T_6 inclusive.

intractable pain due to malignancy of the nasopharynx.[36]

Grant reports forty-nine cases which had rhizotomy of the fifth and ninth cranial nerves and the first, second and third cervical nerves in various combinations. He reports relief in 80 per cent of these cases with a mortality rate of 18 per cent. He does not state how long the patients lived after the operation.[37]

By the time these patients reach the neurosurgeon their lesions are advanced and they are pitiful sights. In view of the extensive nature of the neurosurgical procedure, their poor condition and their susceptibility to pulmonary complications, we believe that if alcohol injection of the fifth nerve does not alleviate the pain, they would fare better on large doses of narcotics or lobotomy.

Paravertebral. There were seven cases

of this type. The apex of the lung was involved in two and the upper thoracic area in five. Three were carcinomas, one a lymphoblastoma and three undiagnosed. The average duration of pain was nine months. The preoperative condition was good in two, fair in one and poor in four. All had received narcotics.

Two patients had a unilateral rhizotomy, one (C_8 to T_6) (Fig. 3), and the other (T_1 to T_5 inclusive). One had a bilateral rhizotomy (T_1 to T_6 inclusive). Two patients had rhizotomy combined with chordotomy and two had medullary spinothalamic tractotomy. Six out of the seven had immediate relief of pain and one could not be evaluated because of disorientation until death. There were four postoperative deaths. One died twelve hours after operation from cardiac metastasis and hemopericardium, one six days postoperatively

FIG. 4. Pain of carcinoma of colon relieved by unilateral chordotomy. Wavy horizontal line shows highest level of temperature loss; straight horizontal line the highest level of pain loss.

from softening of the medulla, one twelve days later from bronchopneumonia and one twenty-one days after operation from bowel distention and pulmonary complications. Three patients were discharged free of pain. One died seven months later with pain above the level of the rhizotomy; another was free of pain three months after operation and follow-up on the third is not available.

Medullary spinothalamic tractotomy gave complete relief of pain in two cases. Both died shortly after operation and observation was too brief for an evaluation. In one death resulted from cardiac metastasis with hemorrhage into the pericardial sac; the second death was due to postoperative medullary softening.

Schwartz and O'Leary reported two cases of chest malignancy subjected to the above operation. Although their patients were relieved of pain, one died thirty-nine hours after operation and the other twenty-nine days later.[38] We believe that the technical difficulties in this procedure make it unsuitable for routine use.

Ray has done multiple posterior rhizotomy in twenty-four patients with apical chest neoplasms. He reports the relief of pain as "eminently satisfactory" but does not give any statistics.[39]

Rhizotomy or rhizotomy combined with chordotomy produced prolonged relief in three of the patients that survived in our series. It appears that a judicious combination at an adequate level of chordotomy plus rhizotomy is a logical procedure for this type of case.

Gastrointestinal. There were seven cases of gastrointestinal carcinoma: two of the rectum, three of the rectosigmoid and two of the colon. (Fig. 4.) The average duration of pain was ten months. The patient's condition before operation was fair in one and poor in six. One patient had received x-ray and radium therapy, one subarachnoid alcohol and all had received narcotics. Bilateral chordotomy was done in four, unilateral chordotomy in two and rhizotomy in one. There was immediate complete relief of pain in all chordotomized patients and partial relief in the one with rhizotomy who complained of girdle sensation.

There was no immediate postoperative mortality. Five patients died: one in three weeks, three in four weeks and one in five weeks after operation.

Two patients were discharged completely relieved of pain but required narcotics. A satisfactory level of anesthesia was obtained in all six cases subjected to chordotomy. Three in this group had persistent impairment of sphincters following operation. Only one had motor weakness; one had persistent pain in the incision. Although all patients having chordotomy were relieved of pain, only two survived longer than five weeks.

It appears from this small group that patients with gastrointestinal malignancy have a shorter postoperative life expectancy than the patients with malignancy of the uterus and cervix. These patients may have fared as well with large doses of narcotics, subarachnoid injection of alcohol or lobotomy.

Pelvic. There were thirteen cases. One carcinoma of the bladder and the rest carcinomas of the uterus and cervix. The average duration of pain was seven months. The patients' condition before operation was good in two, fair in five and poor in six. Most had radium and x-ray therapy

and all required narcotics. Bilateral chordotomy was done in eleven and unilateral rhizotomy in two. There was no immediate postoperative mortality. Ten patients were discharged relieved of pain. Three died: one in three weeks and two in eight weeks.

In the 11 chordotomized a satisfactory level of anesthesia was obtained (T_5 to T_7). Eight of these had impairment of urinary control; in one, temporary and in seven persistent. One patient had a vesicovaginal fistula. Seven patients had motor involvement: four, weakness of one leg; one, weakness of both legs; one, paralysis of one leg; and one paralysis of both legs. Four of the patients had no motor loss. Five of the eleven complained of incisional pain. Although the patients having chordotomy were relieved of pain, their discomfort required some narcotics on discharge.

Although a majority of patients subjected to bilateral chordotomy had some motor or sphincter involvement, the prompt persistent relief of pain justifies this procedure. The purpose of chordotomy is to relieve intractable pain in a patient with life expectancy of three months or longer. The risk, therefore, of bladder and motor complications should not contraindicate its use.

The value of alcohol versus chordotomy for this group has already been discussed. Favorable results in pelvic malignancies following chordotomy have been reported by many investigators.[25,37,41–46]

Skeletal. There were three cases; one hypernephroma with metastasis to the spine and two carcinoma of the breast with metastasis to the spine. The average duration of pain was five and one-half months. Two were in poor condition and one in fair. All required narcotics.

There was no immediate postoperative mortality. The patient with hypernephroma who had a bilateral chordotomy died in four weeks of renal failure and the others were discharged one and three months postoperatively.

The patient with mesencephalic tractomy was relieved of her pain although

section of the tract was incomplete. Pain and temperature was appreciated but recognized as "different." Similar observations have been reported by Walker and by Grant.[46] Walker has reported a total of five cases subjected to mesencephalic tractotomy. He believes that this procedure is in the experimental stage and merits further evaluation.[30]

INTRACTABLE PAIN ASSOCIATED WITH INVOLVEMENT OF BLOOD VESSELS

Cerebrospinal Syphilis with or without Gastric Crises. There were four cases. One had left sciatic pain for one year following injection of bismuth. The second had pain in his feet for eighteen years. The third had gastric crises for twenty-six years and the last had bilateral thoracic and abdominal pain for twelve years which simulated gastric crises. The preoperative condition of the patients was poor in two and good in the others. All had had intensive antiluetic therapy. The first patient had two unilateral chordotomies; the second and third had bilateral chordotomy and the last had a bilateral rhizotomy. The patient with painful feet had partial relief. The other three patients had no relief. There were no postoperative deaths. The two patients who had bilateral chordotomy had no motor loss but incontinence of urine persisted. The results in this group were disappointing.

Beer (1915) was quoted by Shannon[48] as the first to do chordotomy for tabetic crises. Foerster in 1909 was the first to do intradural rhizotomy for this condition.[22]

Kahn and Barney reported twelve patients who had intractable pain of tabes dorsalis. A bilateral chordotomy was presumably done at T_1 with relief in eight cases. However, these authors[23] conclude: "The results were far from perfect."

Hyndman and Van Epps[24] and later Hyndman and Jarvis[49] report eight cases of gastric crises treated by anterior chordotomy at the second and third thoracic segment with complete relief of pain and vomiting in six patients followed twenty-

FIG. 5. Intraetable cardiac pain with aortic regurgitation relieved by a bilateral rhizotomy C_5 to T_5 inelusive. Note anesthesia in these segments following operation.

five, sixteen, fifteen, nine, five and three months, respectively. Bladder funetion was regained gradually in all eases. Loss of sexual funetion was permanent. Verbrugghen,[40] della Torre[50] and Moreno[51] report eases treated by chordotomy.

Cristophe and Buillaume[52] have reported one ease with severe epigastrie pain and vomiting relieved by posterior eommissural myelotomy at thoraeie segment 2, 3 and 4. Wertheimer and Mansuy[53] have reported two eases of gastrie erises whieh were relieved by posterior commissural myelotomy at the third, fourth and fifth thoraeic level. There was temporary dysfunetion of urine and paralysis in the extremities in one case.

The number of cases of gastric crises was too small to warrant any conclusions. It appears from the above reports that most cases of tabes can be relieved by a bilateral ehordotomy at the first or second thoracic level. The procedure of rhizotomy has apparently been abandoned. Posterior commissural myelotomy does not have any advantages over rhizotomy.

Cardiac Pain. There were three cases. One female, age sixty, in good condition had angina for six years. One male, age forty, in fair condition had sternal pain secondary to aortic regurgitation for four months (Fig. 5), and the last case a boy age twelve, in poor condition had intract-able pain in the right side of the chest for nine months seeondary to rheumatie heart disease.

None responded to medieal therapy. The first two had bilateral rhizotomy (C_8 to T_5 inelusive). The boy had unilateral rhizotomy (T_2 to T_5 inelusive by Temple Fay). None eomplained of the anesthesia secondary to the rhizotomy. The relief of pain was immediate and persistent and all were completely free from pain on diseharge. The patients died four months, eight months and three months, respectively, after operation.

Because cardiae patients are poor operative risks it was hoped that this type of pain might be relieved by paravertebral alcohol. White[4] reported sixty-seven cases subjected to alcohol block of the upper thoracic ganglia. The results were excellent in 50 per cent and fair in 30 per cent. Twenty per cent had relief for over two years and 9 per cent for over five years. One patient was relieved for eight years. There was return of pain in only six. Eight per cent died within two weeks after the injection. The advantages for the method are the mild reaction and short hospitalization. The disadvantages are: (1) neuritis in 10 to 20 per cent; (2) pleuritic pain; (3) pheumothorax. (4) possibility of intraspinal injection with paralysis of cord and (5) hyperesthesia of the chest wall. White

concludes: "Surgical resection of the inferior cervical and upper thoracic ganglia, or posterior rhizotomy of corresponding spinal nerves are unquestionably better methods of dealing with cardiac pain than is paravertebral alcoholic injections, pro-

upper five pairs of thoracic roots relieved the animals' pain.

Lindgren and Olivecrona[59] report seventy-one cases of angina pectoris treated by cervicothoracic ganglionectomy (method of Gask and Ross). They removed the

<div align="center">TABLE VI</div>

COMPARISON OF ADVANTAGES AND DISADVANTAGES OF CERVICODORSAL SYMPATHECTOMY VERSUS RHIOTOMY FOR THE RELIEF OF ANGINA PECTORIS AND OTHER TYPES OF CARDIAC PAIN

	Sympathectomy	Bilateral Rhizotomy
Operative shock	Moderate to severe	Moderate to severe
Skin anesthesia	None or slight	Complete in roots cut annoying to some patients
Regeneration of cut fibers	Often occurs	Never occurs
Recurrence of original pain	May occur	Never occurs, may appear above level of section
Return of pain to opposite side	Almost 50% in Lindgren and Olivecrona's cases[71]	Never if complete bilateral section is done
Number of operations necessary for relief.	Two operations in almost 50% of cases	One operation with complete bilateral section of C_8 to T_5 inclusive

viding the patients can tolerate an operation of such magnitude."

Most neurosurgeons agree with White and have resorted to two main types of operations: (1) cervicothoracic sympathectomy and (2) posterior rhizotomy of the upper five pair of thoracic nerves.

Jonnesco[54] did the first sympathectomy for angina pectoris. He removed the stellate ganglia and the sympathetic chain in the neck on one or both sides and reported relief in four patients. Leriche and Fontaine[55] advocated the removal of the stellate and the first and second ganglia. They reported twenty-seven consecutive cases without a fatality. Twenty-six per cent of their patients had complete or nearly complete relief of pain; 15 per cent had considerable relief; 26 per cent experienced moderate improvement and the remainder were unrelieved.

Stimulated by the experimental work of Braeucker[56] and of Spiegel[57] in 1927, White and his associates[58] produced acute coronary occlusion in twenty-one unanesthesized dogs. They found that resection of the upper four thoracic ganglia or the

stellate and the four superior ganglion through an anterior approach. They report complete or nearly complete relief in 44 per cent and in 41 per cent the severe forms were converted to a milder type of pain. Six died within one month after operation, three of these during the operation. Return of pain to the opposite side necessitated a bilateral operation in thirty-four (48 per cent).

According to Lindgren and Olivecrona[59] posterior rhizotomy of the upper thoracic roots for angina pectoris was first proposed by Danielopolu in 1923 and first done by Davis[60] in 1933 (60) who reported a case completely relieved for one year. Theodoresco and Aslan[61] mention a case of angina in which rhizotomy gave relief for over five years. Haven and King[62] operated upon five patients successfully by dorsal root section. Ray[39] states that he has done posterior rhizotomy of the upper five to six roots in six patients. One died of coronary occlusion the tenth day after operation and the others were relieved of their pain. Lindgren and Olivecrona sectioned the upper five posterior thoracic
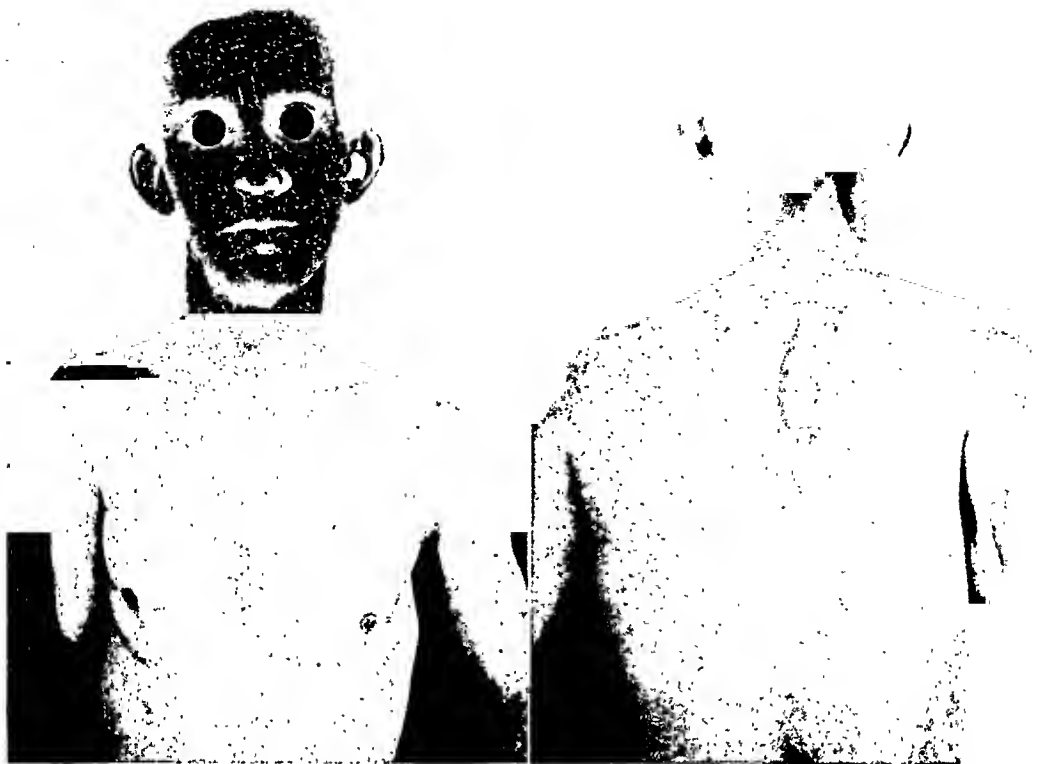
FIG. 6. Phantom limb pain following traumatic amputation; temporary relief following paravertebral novocain block; complete relief after dorsal sympathectomy; (six months' follow-up).

roots in seven patients. The pain recurred in three. In their opinion this procedure was disappointing because there was a high percentage of recurrences, too much discomfort and the mortality excessive. It is not clear whether they did a unilateral or bilateral rhizotomy. A comparison of the value of sympathectomy versus rhizotomy is given in Table VI.

We believe that, although dorsal rhizotomy has certain disadvantages, this procedure can sever at one operation all the afferent cardiac pain fibers without possibility of regeneration. On the other hand, two operations are necessary in almost 50 per cent of the cases when a cervicodorsal sympathectomy is done.[59] Smithwick's operation might prevent regeneration of fibers but for the same reason requires a bilateral procedure. Since it is not entirely disproven that the pregang-lionic fibers cause dilatation of the coronary vessels, the severence of the anterior roots might lead to cardiac

ischemia. Finally, Smithwick's procedure does not include avulsion of the eighth cervical posterior root which Spiegel[57] considers essential for the complete interruption of the higher afferent pathways.

Causalgia. There were five cases, four in the upper and one in the lower extremity. One patient had phantom limb pain following traumatic amputation (Fig. 6); one had burning and aching with phantom pain following gunshot wound of the brachial plexus; and two had burning and aching in the forearm and arm following trauma to the wrist. The last patient had burning and shooting pain into his thigh stump. The duration of pain varied from two weeks to eight years. The preoperative condition of four was good and one was fair; all required codeine. Three had paravertebral blocks with temporary relief followed by dorsal sympathectomy and complete relief for six to eighteen months up to this report.

One patient with a painful leg stump

had alcohol injection of sciatic nerve, periarterial sympathectomy of the femoral artery, removal of neuroma of the sciatic nerve and finally a chordotomy at T_4 which gave an adequate sensory level (T_5) without relief.

One patient with median and ulnar nerve causalgia had novocain block, neurolysis, alcohol block, neurotomy of ulnar and median nerve, periarterial sympathectomy of the brachial artery and rhizotomies from C_4 to T_5 inclusive causing complete deafferentation of the upper extremity but no relief.

During and following the last war numerous articles have appeared on the value of sympathectomy in causalgia.[63-80] In 100 cases of causalgia reported by Rasmussen and Freedman,[77] of which forty had sympathectomy and six nerve operations, the results were said to be satisfactory. Post-ganglionic sympathectomy was done in twenty-one and preganglionic section in fourteen with complete relief in thirteen of the latter group and in only five of the former. The results in treatment of causalgia of the lower limbs were less satisfactory than in the upper limbs. Mayfield and Devine[70] report fifteen cases of severe causalgia, twelve of which were relieved by preganglionic sympathectomy (T_2 and T_3). One was improved by fever therapy and two recovered spontaneously. The authors believe that the site of injury must be included in the denervated area. Hyndman and Wolkin[78] believe that only the second dorsal ganglion must be removed for complete sympathectomy.

Horrax[32] resected the parietal cortex in two patients with causalgia having phantom limb pain with only temporary relief. Mahoney[31] secured relief for two years in his case by a similar procedure.

Paravertebral novocain and alcohol injections have been tried by several investigators.[69,79-81] The danger of alcoholic neuritis in most cases almost precludes its use. Novocain injection, which is of important diagnostic value, gives tem-

porary relief in most cases and prolonged relief occasionally after repeated injection.[69]

Our cases and those presented by others illustrate the superiority of dorsal preganglionic sympathectomy over chordotomy and rhizotomy for this type of pain.

Vascular Occlusive Disease of Extremities. There were two cases. One, a male, age thirty-five, was in poor condition. He had intractable pain in the feet due to Buerger's disease with massive edema of the legs and gangrene in the big toes. (Fig. 7.) He had a right lumbar sympathectomy with relief for one year and was refused a second sympathectomy. He required morphine and had to sleep in a chair for eleven months because of unbearable pain when lying down. A bilateral chordotomy was done at T_3 to T_4 with immediate relief of pain. There was temporary urinary retention but no loss in motor power. Subsequently, the edema receded and both legs were amputated. The patient now has a bilateral prosthesis and operates a radio shop.

The second patient was a male alcoholic, age thirty-eight, in poor condition, who had had a bilateral amputation of the legs at the thighs for Buerger's disease. He had osteomyelitis of the left femur and refused redressings because of severe pain. He had phantom pain in both extremities, more on the left, and required morphine. Paravertebral block and unilateral sympathectomy gave slight relief. A chordotomy was done at T_4 on the right with complete relief of pain on the left without bladder or motor impairment. This patient was readmitted three years later for an acute cardiac condition but he had no pain in the left stump.

The above cases suggest that chordotomy can give relief of intractable pain in the lower extremities caused by vascular occlusive disease. In one case pain was due to gangrene in both feet and in the other to osteomyelitis in the stump. White,[71] Verbrugghen,[40] Taylor[82] and Falcone and Lindsay[83] believe that painful stumps can be relieved by chordotomy. Pool[86] and

FIG. 7. A, gangrene of both feet due to Buerger's disease; massive edema in both legs due to sleeping in chair for eleven months; B, complete relief of pain after bilateral chordotomy with improvement in condition and permitting first amputation; right leg subsequently amputated; bilateral prosthesis; patient was free of pain and runs radio shop three years after amputation.

Browder and Gallagher[87] have relieved the vise-like pain of phantom limb in a few cases by section of the posterior column.

INTRACTABLE PAIN DUE TO MISCELLANEOUS CAUSES

There were four patients. One female, age thirty-four, in poor condition who required narcotics, had severe suprapubic pain caused by tuberculosis of the bladder. There was complete relief until death one and one-half years later following bilateral chordotomy (T_2 to T_3). There was temporary motor weakness but no incontinence because of preoperative nephrostomy.

One male, age thirty-four, in poor condi-

tion had a laminectomy elsewhere for compression fracture with paraplegia at T_{12}. Because of abdominal pain a bilateral chordotomy and rhizotomy was done at T_9 and chordotomy again at T_1 with only temporary relief. The patient died two months postoperatively of renal failure.

A female, age fifty, in good condition had bilateral chest pain for three months secondary to draining sinuses following gallbladder surgery. At operation an arachnoditis was found. A bilateral rhizotomy was done at T_5 to T_7 inclusive with partial relief of pain when last seen three and one-half years after operation.

A male, age forty-three, in fair condition complained of burning, itching and a

crawling sensation for sixteen months in the opthalamic division following severe herpes zoster. These procedures gave temporary relief: (1) paravertebral novocain block in the upper sympathetic ganglia; (2) supra-orbital neurectomy and (3) rhizotomy of the fifth nerve. Following rhizotomy he was relieved of some pain but complained of "tightness in his face" which was "driving him frantic." A cortical operation was proposed but refused.

The only case in this group presenting an unusual problem was the one with pain due to herpes. Although rhizotomy relieved his "burning," the patient stated that this operation gave him a "tightness" of his face and that he was worse than before operation. There are few reports on the relief of facial herpetic pain by neurosurgical procedures. Sjöqvist[83] reports such a case relieved by medullary tractomy. Bucy has resected the face area of the sensory cortex bilaterally in one case without relief of pain; a prefrontal lobotomy is contemplated in his case.

INTRACTABLE PAIN OF UNKNOWN ETIOLOGY WITH NEUROSIS

There were five white females who required narcotics. All had preoperative psychiatric evaluation.

The first patient, L. R., age sixty-four, had low back and left sciatic pain for six months without history of trauma. She was emotionally unstable. There was evidence by neurologic examination and myeologram of a disc at L_5. Operation at this level revealed a slight protrusion but gave no relief. Psychiatric examination revealed a severe neurosis but chordotomy was recommended because of persistent pain. This was done at T_5 giving a satisfactory sensory level on the left at T_7. There was temporary urinary incontinence but no motor loss; no relief was obtained and the patient was institutionalized.

The second, H. K., age thirty-four, had low back and bilateral sciatic pain for three years. Discs were removed elsewhere at the fourth and fifth lumbar interspace

on two occasions with no relief. She had marked emotional instability. Re-exploration revealed a large lumbar epidural cyst which was removed with temporary relief. Metycaine caudal block gave temporary relief. Psychiatric examination revealed a severe neurosis but left chordotomy at T_2 was recommended because of intractable radiculitis. There was temporary relief on the right but aggravation of pain on the left. A chordotomy was then done at T_1 on the right with temporary relief on the left and she was discharged improved. She returned nine months later with bilateral sciatic pain more on the right. A paravertebral alcohol block on the right gave no relief and resulted in foot drop. Another chordotomy was done at T_3 on the left with a deeper incision and without relief. A right lumbar sympathectomy was unsuccessful. One cc. of subarachnoid absolute alcohol at the fourth lumbar level gave no relief. There was no motor loss following the chordotomies but there was temporary loss of sphincter control. Tetraethyl ammonium bromide was given intravenously with no effect on pain. She was discharged unimproved.

The third patient, M. B., age thirty-four, had pain for twelve months in the right loin radiating to the lower costal and inguinal areas following a fall. Psychiatric examination revealed a neurosis but operation was advised because of severe pain. A right paravertebral novocain block from T_{10} to L_2 inclusive gave no relief. An ascending spinal anesthesia gave complete temporary relief when the level reached T_6. Accordingly a rhizotomy was done on the right from T_6 to T_{12} inclusive. One year follow-up showed no relief but a patient addicted to narcotics.

The fourth patient, L. S., age thirty-six, had excruciating low back and bilateral sciatic pain for seven years. She had many operations elsewhere: Laparatomies, coccygectomy, lumbar laminectomy with disc removal, lipiodal installation and finally re-exploration of the lumbar area with no relief. The neurologic examination and the

myelogram showed involvement of the cauda equina. The psychiatrists agreed on another exploration. This showed an extensive arachnoiditis and encysted lipiodal. An attempt was made to free the roots but the lesion was extensive and there was no

revealed narcotic addiction and persistent pain.

The results in this group were unsatisfactory. We could not find any reports on a similar group. Bunts[85] describes three cases of chronic neuralgia relieved by

TABLE VII
RELIEF OF PAIN FROM VARIOUS NEUROSURGICAL PROCEDURES IN FIFTY-THREE CASES OF INTRACTABLE PAIN (FIFTY-SEVEN WITH FOUR DEATHS)

	Complete	Per cent	Partial	Per cent	None	Per cent
Immediate relief......................	35	66	8	15	10	19
Late relief..........................	32	60	9	17	12	23

relief. A chordotomy was done (T₃ right) with a satisfactory level on the left at T_7 and complete relief of pain on this side. There was temporary retention of urine. Because of pain in the right leg a chordotomy was then done at T_4 on the left with a sensory level at L_2 on the right and no relief. Tetraethyl ammonium bromide (100 mg.) was given intravenously without amelioration. A chordotomy was then done at T_4 on the left under local anesthesia and gradually deepened beyond maximum depth without any change of previous sensory level on the right and with no suppression of pain. The patient was discharged unimproved.

The fifth patient, J. Z., age thirty-six, had girdle pain for eight years across the lower chest. A lipiodal injection followed by a thoracic laminectomy was done elsewhere with no relief. The psychiatrist suggested re-exploration. Thiamine chloride given intraspinally did not help. Laminectomy revealed an arachnoiditis with encysted lipiodal. A rhizotomy at T_8 to T_9 bilaterally gave temporary relief.

The sixth patient, H. H., age sixty-nine, had pain in the right posterior chest for two years. She took large doses of narcotics. An exploratory laminectomy was negative and a unilateral rhizotomy from T_5 to T_8 inclusive was done on the right with no improvement. Follow-up three years later

rhizotomy but he does not mention an associated neurosis. Our patients had pain in various areas but the true etiology was obscure and complicated by an associated neurosis.

We believe that absolute alcohol, rhizotomy, spinothalamic tractotomy and sympathectomy is contraindicated for the relief of intractable pain of unknown etiology with neurosis. Prefrontal lobotomy may prove to be the procedure in this type of case especially if there is an associated narcotic addiction.

RESULTS

Fifty-seven cases of intractable pain were subjected to sixty-two neurosurgical procedures with the following results (Tables VII and VIII): (1) Sixty per cent had complete relief of pain, 17 per cent partial and 23 per cent no relief. (2) There were four postoperative deaths in the entire series (6.4 per cent). All four occurred in patients with malignancies. On death occurred after chordotomy and rhizotomy; one after rhizotomy of the fifth and ninth cranial, first, second and third cervical; and two deaths after medullary spinothalamic tractotomy. (3) There were thirty-four chordotomies in the entire series, fourteen unilateral and twenty bilateral with no operative mortality. Approximately 20 per cent in this group had

temporary bladder dysfunction and motor weakness. Eighteen per cent had annoying chest pain secondary to chordotomy.

SUMMARY

The common causes for intractable pain are presented. Minor and major neurosurgical procedures for its relief are listed.

cedures and contraindications to their use. The possibilities of recent procedures such as resection of the sensory cortex and prefrontal lobotomy are discussed.

CONCLUSIONS

1. The results from combined section of the fifth and ninth cranial and upper

TABLE VIII

DEATHS WITHIN FOURTEEN DAYS AFTER VARIOUS NEUROSURGICAL PROCEDURES FOR THE RELIEF OF INTRACTABLE PAIN

Operation	No.	No. of Deaths	Cause of Death
Chordotomy			
Unilateral	14	0	
Bilateral	20	0	
Rhizotomy			
Unilateral	7	0	
Bilateral	9	0	
Chordotomy and Rhizotomy	2	1	Bronchopneumonia (12 days)
Rhizotomy, 5th and 9th cranial, C_1, C_2, C_3	3	1	Postoperative shock (18 hr.)
Medullary spinothalmic tractotomy	2	2	Medullary softening (24 hr.) cardiac metastasis with hemopericardium (6 days)
Mesencephalic spinothalamic tractotomy	1	0	
Sympathectomy	4	0	
Total	62	4 (6.4%)	

The advantages and disadvantages of subarachnoid and paravertebral alcohol injections are compared with those of chordotomy, rhizotomy and sympathectomy.

Fifty-seven cases of intractable pain in which operation was performed by the authors are then presented in the following groups: (1) malignancies, nasopharynx and neck, paraveretbral, gastrointestinal, pelvic and skeletal; (2) vascular: neurosyphilis with and without tabetic crises, causalgia with and without phantom pain, cardiac (angina); (3) miscellaneous: tuberculosis of the bladder, arachnoiditis, herpes zoster and fracture of the thoracic vertebra; (4) unknown etiology with neurosis.

The relief of pain, mortality from operations and complications, are listed in tables. Each group is then analyzed and the results compared with those published by others. Conclusions were then made as to the relative merits of the various pro-

three cervical roots in our small group of nasopharyngeal malignancies was disappointing. We believe that if alcohol injection of the fifth nerve does not alleviate the pain, these patients would fare better under medical care or psychosurgery.

2. Adequate rhizotomy or rhizotomy combined with chordotomy appears to us the procedure of choice for the relief of pain caused by paravertebral malignancies.

3. Chordotomy relieved the intractable pain caused by malignancies of the abdomen. In our series of seven cases the survival period following operation was short. Perhaps the use of subarachnoid alcohol and narcotics might have been preferable.

4. The best results following chordotomy for malignancies occurred in those of the pelvis. If life expectancy is above three months, chordotomy appears to us the procedure of choice.

5. The number of cases of gastric crises

was too small to warrant any conclusions. However, reports in the literature suggest that bilateral chordotomy at the first or second thoracic level may offer relief.

6. Recent advance in psychosurgery such as unilateral lobotomy or thalamotomy may prove of value in many cases.*

7. Intractable cardiac pain was completely relieved in three cases in which posterior rhizotomy was done. Our preference for this procedure over sympathectomy has been discussed.

8. Dorsal preganglionic sympathectomy is superior to rhizotomy and chordotomy for causalgia of the upper extremity.

9. Two cases of vascular occlusive disease (Buerger's), one with intractable pain caused by bilateral gangrene and the other with a painful stump, were completely relieved by chordotomy.

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* By means of a steriotaxic technique developed by Spiegel et al. (SPIEGEL, E. A., WYCIS, H. T., MARKS, M. and LEE, A. J. Steriotaxic apparatus for operations on the human brain. *Science*, 106: 349–350, 1947, and also personal communication from the authors.) lesions were made in the spinothalamic tract, in the mid-brain alone or combined with lesions of the dorsomedial nucleus of the thalamus for the treatment of intractable pain. Two groups of cases were described. In the first group (three cases) lesions of the pain-conducting pathways in the mid-brain were combined with lesions of the dorsomedial nucleus of the thalamus. One patient was completely relieved while the other two were partially relieved and no longer required narcotics.

In the second group (three cases) lesions were limited to the mid-brain alone. All three patients had a reduction of their pain and no longer required narcotics. The follow-up period on the above cases is too short for a final opinion as to the value of the procedure for the relief of the pain.

On April 12, 1949, Scarff reported a series of thirty-three cases of intractable pain treated by unilateral prefrontal lobotomy before the combined meeting of the Philadelphia and New York Neurological Society. It did not matter which side of the brain was operated upon. For example, lobotomy on the right side gave relief for right-sided pain as well as contralateral pain. Although the total follow-up period was no longer than one year, he reported good results in 60 per cent, fair in 18 per cent and poor in 15 per cent. He also stated that in certain cases there was relief of narcotic addiction without withdrawal symptoms.

Shenkin and Groff who discussed Scarff's paper also reported their results with unilateral lobotomy in fifteen cases. Although they had good results in some cases, the follow-up period was too short for final comment.

10. Six cases of intractable pain of unknown etiology associated with neurosis failed to respond to any neurosurgical procedure. The use of absolute alcohol, rhizotomy, spinothalamic tractotomy or sympathectomy is contraindicated in this type of case. Prefrontal lobotomy may prove of value in these patients.

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Discussion of this article by Drs. A. Earl Walker, James L. Poppen, Ernest A. Spiegel and James W. Watts will be included in the reprints.

FAT EMBOLISM*

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FAT embolism has been recognized as a disease entity for over half a century.[1] Nearly all that is known about it can be found in Warthin's exhaustive monograph which was published in 1913.[2] Yet the condition is sufficiently rare and its manifestations are so easily ascribed to "shock" or "heart failure" that many are still not only ignorant of its features but actually doubt its occurrence. When Robb Smith[3] reported seventy cases in 1941, "The Lancet" thought it necessary to editorialize to the effect that now there was no doubt as to the reality of the condition. Many surgeons of great experience in World War II believe that they did not see a single case. It seems desirable, therefore, in spite of its apparent rarity, to summarize the known facts about fat embolism and to record some personal observations on the value of x-ray in diagnosis and oxygen in treatment.

PATHOGENESIS

Three conditions are necessary for development of fat embolism: (1) liquid fat, free in the tissues, (2) torn and patent veins and (3) an increase of local tissue pressure above the level of the venous pressure. Such factors may arise after fractures, blast injuries, burns, extensive contusion of subcutaneous tissue and surgical operations. This is particularly the case in simple comminuted fractures of the femur or tibia. Compound fractures, because of the associated decompression of the soft tissues, are less likely to produce fat embolism unless an open reduction with primary closure of the wound is performed.

When fat enters the circulation, it is carried first to the lungs where it lodges in capillaries, interferes with normal oxygen exchange and produces an alveolar exudate composed largely of red blood cells and serum. Some of the fat is squeezed through the pulmonary circuit and is then distributed widely throughout the body. However, it appears to be well tolerated by most organs except the brain. Here it produces occlusion of capillaries, a rim of necrosis in the adjacent cerebral tissue and perivascular hemorrhages. These changes are accompanied by cerebral symptoms which vary from a mild psychosis to clonic convulsions and coma. In the kidney, on the other hand, the presence of large amounts of fat appears not to interfere with renal function. Nephritis or renal failure do not occur even when the glomerular capillaries are extensively involved.[2,4] Fat enters the coronary vessels but it is doubtful whether it ever is sufficient to produce heart failure.[4]

Death in fat embolism is predominantly pulmonary or cerebral, or a combination of these two. There is remarkably little correlation between the pulmonary and cerebral forms of fat embolism except that some degree of pulmonary involvement must occur before the brain is involved. In some cases fat passes through the pulmonary circuit without producing appreciable symptoms only to cause fatal cerebral embolism. This may occur without a patent foramen ovale.[5] In other cases there are predominant pulmonary signs although at postmortem there may be slight to moderate cerebral involvement.

These vagaries in the action of circulating fat have led to the hypothesis that it produces a specific toxic effect quite apart from the mere occlusion of blood vessels.[6] There are two facts which tend to substantiate this view: First, the amounts of neutral fat necessary to produce fatal embolism in experimental animals exceeds the

estimated amount of fat in the marrow of the femur of man. Second, an extraordinary tolerance to fat can be established experimentally by repeated injections of less than the minimum lethal dose. After a series of such injections an animal can tolerate many times the minimum lethal dose. The physical state of the fat is probably of greater importance than the amount. Hydrolyzed human fat, for example, is much more toxic than neutral fat. Oleic acid is thought by some investigators to be the toxic agent.[6] Be that as it may, specific alterations in the physical state of the fat probably account for its paradoxical action in particular cases; that is, pulmonary without cerebral signs in some cases, cerebral without pulmonary signs in others and at times both forms. It is obvious, of course, that in massive, rapidly fatal embolism pulmonary death would occur before cerebral signs had time to develop.

INCIDENCE

It is likely that small amounts of fat enter the circulation very frequently. Scriba[7] found fat in the urine of 80 per cent of patients with fractures. After death from extensive injuries fat can be demonstrated in the pulmonary vessels in over 50 per cent of cases.[8] In a careful postmortem study of sixty battle casualties Mallory found evidence of fat embolism in forty.[9] In ten of these cases it was extensive. On the other hand, fat embolism as a principal cause of death is uncommon. Wilson and Salisbury[10] recognized eight cases, six of which were fatal among 1,000 battle casualties. Of 30,000 patients (medical and surgical) treated in an Army General Hospital only two were thought to have fat embolism, and in only one of these patients was the diagnosis clearly established. Although admittedly rare, it is important to emphasize that many cases are overlooked and that the recorded incidence is proportional to the interest which surgeons and pathologists take in this condition. Thus, prior to 1935 the diagnosis had not been made at the Toronto General Hospital. In the next four years, due to the interest of Harris and his colleagues, twelve cases were recognized.[11]

DIAGNOSIS

The presence of fat embolism should be suspected under the following circumstances: (1) An injury to bone, especially simple fractures of the tibia or femur, extensive soft tissue injuries or, less commonly, surgical operations in which large amounts of fat are excised or unduly traumatized; (2) a free interval which may vary from a few hours to nine or ten days; (3) the onset of pulmonary or cerebral symptoms, or both.

The free interval between injury and onset of the embolism is one of the valuable features in establishing a diagnosis. Sometimes fat embolism occurs without a free interval and under such circumstances it may be impossible to make the diagnosis. However, pulmonary signs, such as cyanosis, dyspnea and pulmonary edema, are not characteristic of shock, nor are cerebral changes such as tonic convulsions and coma. If any of these signs occur in the course of shock treatment and are not explained by concomitant severe sepsis or pulmonary or cerebral injury, the possibility of fat embolism should be considered. It is quite likely that some cases of so-called irreversible shock without extensive tissue necrosis or sepsis are due to a combination of blood loss and fat embolism.

The pulmonary manifestations of fat embolism may vary from a moderate elevation of the respiratory rate with fever to severe pulmonary edema with dyspnea, cyanosis and frothy sputum. An electrocardiogram may be helpful. It was obtained in our patient, with the finding of normal tracings. The cerebral signs of fat embolism also vary from mild psychosis or confusion to clonic convulsions, generalized rigidity and coma. Localizing signs do not occur and there is no increase in intracranial pressure. The deep tendon reflexes may be exaggerated and occasionally a
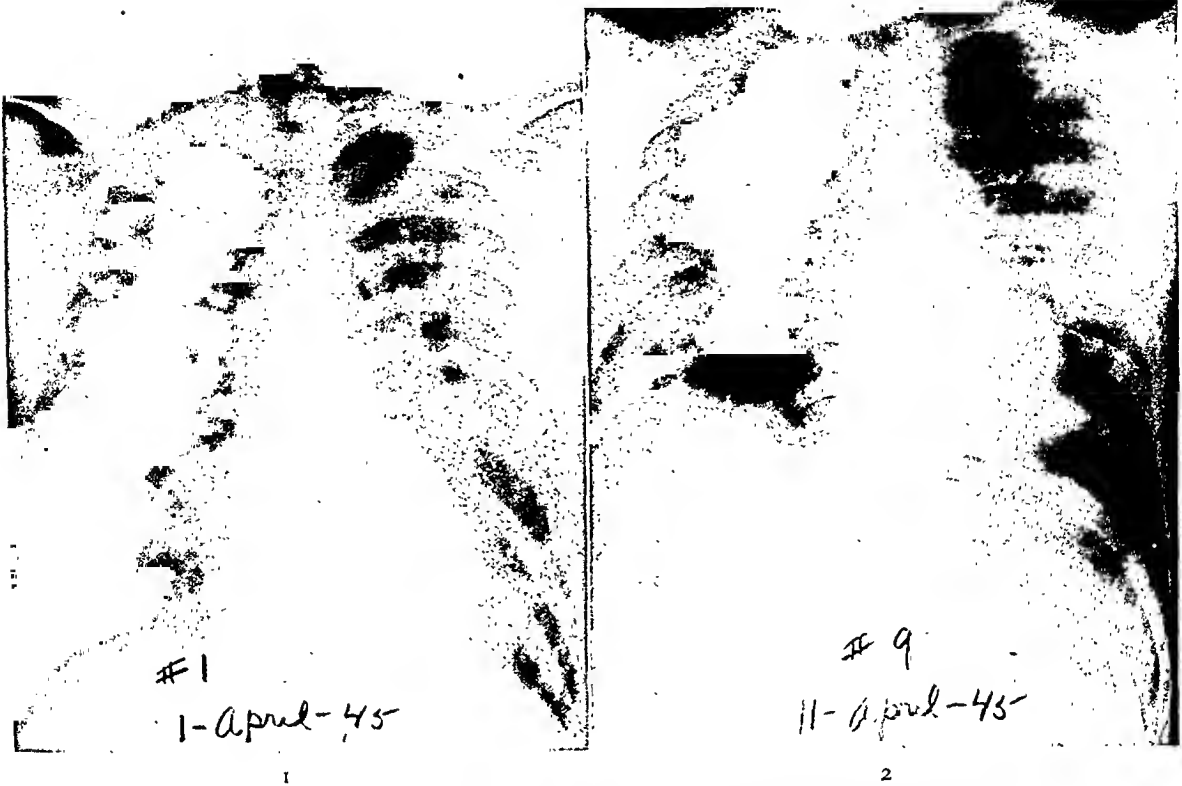
FIG. 1. X-ray taken on the first day after onset of embolism; diffuse clouding was present throughout both lungs, the involvement in the upper lung fields being as extensive as in the hilar area and bases.

FIG. 2. X-ray taken eleven days after the embolism; examination of the lungs was practically negative but still considerable cloudiness was seen by x-ray.

positive Babinski has been noted. That these signs are, in part, due to anoxia is evident from the striking improvement in the cerebral state which was produced by administration of oxygen in our case.

When both pulmonary and cerebral signs appear after a free interval, the diagnosis is almost unmistakable. If the symptoms are mild and are only of the cerebral or pulmonary type, the diagnosis is easily overlooked. Fever and a slight elevation of the respiratory rate after a free interval of several days should arouse a suspicion of fat embolism, particularly if a suspected pneumonia fails to respond to therapy. Similarly, mild psychosis or mental confusion may be the only clue and should not be casually ascribed to old age or questionable alcoholism.

One should look for petechial hemorrhages in the skin and mucous membranes. When present, these together with cerebral or pulmonary signs are practically diagnostic. Occasionally eyeground changes, particularly petechial hemorrhages, have been noted.

X-ray. Use of x-ray in diagnosis has been suggested by Scuderi.[6] He found that in dogs the injection of small amounts of sterile oleic acid produced a diffuse cloudiness of both lung fields in films taken twenty-four to forty-eight hours later. Very few x-ray examinations of the lungs for fat embolism in man have been reported. Whitaker[12] and Sophian[13] have noted areas of patchy consolidation and Kolmert[14] described diffuse haziness and cloudiness of the lung fields which persisted for many days after the pulmonary symptoms and signs had disappeared.

Our observations are similar to those recorded by Kolmert. Films taken on the first day after onset of the embolism (Fig. 1) showed diffuse clouding throughout both lungs, the involvement in the upper lung fields being as extensive as in the hilar area and bases. This initial picture is characteristic of acute pulmonary edema.

FIG. 3. X-ray taken eighteen days after the embolism; physical examination of the chest was negative but still some residual cloudiness was seen in the x-ray, especially in the left upper lung field.

The changes in the film are similar to those seen after myocardial infarction. At the time this film was taken there were coarse bubbling rales throughout both lung fields. It is interesting that in the course of the next few days there was striking improvement in the involvement of the chest by physical examination and in the general condition of the patient but films taken on the fifth day showed that the involvement of both upper lung fields and the right base had increased.

Eleven days after the embolism examination of the lungs was practically negative but there was still considerable cloudiness by x-ray. (Fig. 2.) By the eighteenth day the patient had recovered almost completely. Physical examination of the chest was negative. However, there was still some residual cloudiness in the x-ray, especially in the left upper lung field. (Fig. 3.) It was not until twenty-five days after the onset that a chest film was negative of cloudiness.

Laboratory Studies. A valuable bit of confirmatory evidence in establishing the diagnosis of fat embolism is finding fat in the urine and sputum. After about thirty-six hours fat may be demonstrated in the sputum. In searching for fat in the sputum, Seuderi[6] points out that the stain must be fresh, a high concentration of Sudan III is necessary and the stain must be kept in contact with the fat for at least five minutes.

Fat droplets appear in the urine usually after the fifth day. In searching for fat droplets only the last few cc. of a voided specimen should be examined since the fat tends to float on the surface. Occasionally fat can be demonstrated by the "sizzle test." A drop of the last few cc. of a voided specimen of urine is taken up on a platinum loop and held over a gas flame. If fat is present, a sizzling and popping occurs. According to Seuderi, this test is sensitive in dilutions of fat in water to 1: 1,400.

The spinal fluid in fat embolism with cerebral signs is negative. Occasionally slight increases in pressure have been present. Normal electrocardiographic tracings have been described in fat embolism. The possible value of this fact in distinguishing fat embolism from pulmonary edema due to heart failure has been mentioned.

Quantitative examinations of the blood for fat are of no help in fat embolism. However, there is some evidence that dark field examinations of blood for fat particles might be of value in massive embolisms.[6]

A rapid fall in hemoglobin and hematocrit concentration have been described as features of fat embolism. The loss of blood is ascribed to extensive hemorrhages in the lung.[11] Although in our case the initial hematocrit level was 39 and remained below 40 for several days despite whole blood transfusion, this was ascribed to loss of blood associated with the fracture rather than to a specific feature of the fat embolism.

TREATMENT

The treatment of fat embolism is usually regarded as being of no avail. In many publications use of oxygen is not even men-

tioned. However, Kolmert[14] has called attention to the specific value of oxygen in high concentration and our experience confirms his observations. In our patient high concentrations of oxygen administered by a closed B.L.B. mask brought about dramatic improvement. Throughout the first two weeks of the illness use of oxygen had a beneficial effect. In the beginning it changed semicoma to consciousness with delirium. Later it changed delirium to a responsive mental state. Similarly cyanosis was relieved and the respiratory rate was lowered. It was not until the thirteenth day after the embolism that the patient could get along all day without oxygen. During the first seventy-two hours oxygen was given continuously. If it was stopped even for a minute or two, the patient would lapse into semiconsciousness, become extremely cyanotic and appear moribund. The fact that the patient was a pilot trained to use and wear an oxygen mask enabled him to tolerate it extremely well. Even when disoriented, he tended to replace rather than remove the mask. Had he been one of those patients who fight an oxygen mask, it is our opinion that he would not have survived the critical first three days of the illness.

In addition to oxygen, penicillin and sulfadiazene were given in full therapeutic doses. Blood and plasma were given liberally as indicated by plasma protein and hematocrit determinations. At least 1,000 cc. of one or the other were given daily for the first ten days until the patient began to take food by mouth.

Use of hydrolyzing agents such as decholin have been suggested in the treatment of fat embolism. Because the available evidence indicates that hydrolyzed fat is more toxic than neutral fat, use of these agents seems questionable. Further studies along these lines are indicated however.

Since in some cases there have been repeated episodes of fat embolism, use of vein ligation should be considered. It is interesting that this was suggested by Warthin in 1913.[2] We did not think it

feasible in our patient but under certain circumstances it would seem worth while.

CASE REPORT

A twenty-five year old officer entered the hospital five hours after he had sustained bilateral fractures of the femur. The manner in which he was injured is of interest. While on a mission over Germany, the landing gear of his plane had been damaged by flak. On returning to his base he was ordered by radio to bail out. At 4,000 feet he dove head first out of the cockpit. Apparently the horizontal stabilizer of the tail struck him across his thigh. "I knew my legs were broken. I felt sick as I glided down and wished that the chute would descend faster." At about 1,000 feet he lost consciousness.

When he regained consciousness, he was lying on the ground and was unable to move his legs. He was in severe pain but with the aid of a French civilian he found his medical kit and gave himself an injection of morphine. One hour and a half after the jump he was picked up by some American engineers, placed without splints in a truck (his legs were wrapped in his parachute) and he was transported to the hospital.

Physical examination on admission showed a well developed male in severe shock. He was pale, sweating and looked acutely ill. The temperature was 101°F.; pulse, 120; blood pressure, 78/42.

The patient was given 1,000 cc. of plasma and 1,000 cc. of whole blood. Both legs were immobilized in Thomas splints with 10 pounds of balanced adhesive traction. The patient responded very well. The blood pressure returned to 105 systolic, the pulse slowed and the patient felt sufficiently comfortable to talk and render an intelligent account of the accident.

Several hours later, because of a decline in his blood pressure, he was given an additional 500 cc. of plasma. Four hours after this infusion had been finished and twenty-three hours after the original injury he suddenly became semicomatose. There was generalized spasm and muscular rigidity. He was given oxygen by means of a B.L.B. mask. This produced some improvement in his respirations, but the cyanosis continued and he remained irrational and semicomatose. Examination of the chest disclosed diffuse, coarse, moist bubbling rales

throughout both lung fields. There was no distention of the neck veins and the veins of his hand collapsed readily on elevation. The blood pressure, which had become inaudible just after the episode, returned and stabilized around 100 systolic. Neurologic examination disclosed no abnormality other than some increased activity of the knee and ankle jerks. There were no localizing signs of cerebral injury. A diagnosis of probable fat embolism was made at this point.

Laboratory studies about twelve hours after onset of the embolism were as follows: Hematocrit, 37.8; total protein, 7.2 Gm. per cent. Urine: albumin, 3 plus; no fat could be demonstrated in the urine or sputum. An electrocardiogram showed normal tracings. A film of the chest showed changes in both lung fields. (Fig. 1.) On the fifth day after the onset of embolism fat was demonstrated for the first time in the urine and sputum.

The patient remained irrational and semicomatose for two days. He had frequent spells of generalized rigidity and was incontinent of urine and feces. The rectal temperature ranged between 100 and 102°F. Physical examination of the chest showed progressive improvement in the extent and coarseness of the rales. However, x-ray examinations disclosed no improvement; in fact, the changes were more marked on the fifth day, suggesting a superimposed pneumonia. X-rays on the eleventh and eighteenth days still showed residual cloudiness in the lung fields although physical examination of the chest was negative. (Figs. 2 and 3.)

The patient required oxygen constantly. The moment it was stopped he became intensely cyanotic and comatose. During the first forty hours it was administered without interruption. After that time, because of fear of producing an irritation of the upper respiratory tract, an attempt was made to stop the oxygen for a few minutes every four hours. During the first week it was not possible to do this for more than five minutes. It was not until the seventh day that he could get along without the mask for intervals of as long as ten minutes.

In addition to oxygen the patient received sulfadiazene and penicillin. He was given parenteral fluid as high as 3,000 cc. daily for the first week; 1000 cc. of this was blood or plasma. After the tenth day he could take food and liquids by mouth.

There was steady improvement in the cerebral state. By the end of the third day, although disoriented, he was responsive and occasionally cooperative. After seven days he had occasional lucid moments interspersed with hallucinations. On the thirteenth day he had no oxygen and from then on he improved rapidly. However, although he appeared and talked rationally, he had no recollection of events which had happened only a few hours previously. By the thirtieth day his mental state was normal without evidence of residual disturbances. However, he had a period of total amnesia covering the time of onset of the embolism to the twentieth day. Although he could remember the accident and his initial care in the hospital, he could recall nothing of the subsequent eighteen days of his illness. People whom he had seen daily for eighteen days required an introduction on the twentieth.

The fractures were manipulated on the sixteenth and eighteenth hospital days under pentothal anesthesia. Convalescence from that time until he was evacuated to the zone of the interior was uneventful.

SUMMARY

1. Fat embolism can be demonstrated pathologically in about 50 per cent of fatal injuries, especially in closed fractures of the tibia and femur. In about 25 per cent of these cases it is a contributing cause of death.

2. Clinically, fat embolism is not common but the diagnosis can be established on the basis of characteristic signs and symptoms and can be confirmed by x-ray and laboratory data.

3. In occasional patients dramatic improvement with recovery may follow use of high concentrations of oxygen.

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Dr. Bauer at the Mariestad Hospital in Sweden and others have found that anticoagulant therapy is effective in the treatment and prevention of major postoperative attacks of vascular thrombosis. Heparin does *not* dissolve clots already formed, hence one should wait until all oozing at the operative site has subsided before starting on heparin. Dicumarol is also very effective in these cases and the combined prompt and proper use of these anticoagulants should greatly reduce the incidence of a fatal outcome in such cases. (*Richard A. Leonardo, M.D.*)

ACUTE APPENDICITIS IN INFANTS AND CHILDREN UNDER TEN YEARS OF AGE*

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THIS study of acute appendicitis in infants and children up to ten years of age in Harlem Hospital covers a period of twelve years from 1935 to 1946, both years inclusive. All patients treated in this hospital were service cases; no special surgical team treated them. The surgical team which was on call at the time of admission of the patient took care of that particular patient. No special outline of treatment was followed. In other words, the entire care and management of the patient was for the most part left to the surgeon in charge of the case. All patients were operated upon at the earliest possible time after the diagnosis was made. One might expect, and correctly so, I believe, that service cases will be admitted to the hospital later than private cases and, therefore, one would expect a slightly higher morbidity and mortality.

It is the generally accepted opinion that an appendix of a child under ten years of age diagnosed microscopically as lymphoid hyperplasia is a normal appendix; in other words, it cannot be considered acute. For this reason all cases in which the diagnosis of lymphoid hyperplasia was made have been eliminated from this survey. Cases in which the surgeon or the pathologist made a diagnosis of chronic appendicitis have also been eliminated. A total of 210 case reports were reviewed but after eliminating the aforementioned type of case there were 194 cases which will serve as the basis for this study.

It has been said that the cough is the guardian of the respiratory tract. By the same reasoning we might state that the omentum is the guardian of the peritoneal cavity as it has the quality to limit the spread of peritonitis by sealing off the inflammatory process. In infants and children the omentum is not fully developed and for that reason the spread of an inflammatory process is much more rapid than in adults. As can be seen in Table 1, the younger the patient the less frequent the occurrence of appendicitis.

TABLE 1

Age (yr.)	No.
0-2	9
2-4	8
4-6	37
6-8	57
8-10	83
Total	194

Incision. One hundred three right rectus muscle splitting incisions and sixty-four McBurney incisions were used on the patients operated upon as covered by this study. For the remaining cases the types of incisions were not mentioned. It is noted, however, that within the last three or four years the McBurney incision has been used much more frequently than it was previously.

Of the total number of operative deaths, eighteen in number, the right rectus incision was made in thirteen cases and in five cases the McBurney incision was made.

Of the fourteen patients who died from peritonitis, ten were operated upon through the right rectus muscle splitting incision and in four cases the appendix was removed through the McBurney incision. We are unable to tell what change in mortality there might have been had the McBurney incision been used in all cases. However, it is generally conceded that McBurney's incision is the one of choice

when the diagnosis is fairly certain and in cases which are to be drained.

Meyer[1] states, " . . . we have used the maxim that the closer to the mid-line the appendectomy is performed, the higher the mortality rate." From the findings in this study the above statement is correct.

Drainage. Much has been written and is being written on drainage of the peritoneal cavity in peritonitis. The general trend is that the peritoneal cavity should not be drained. Arguments against drainage are: (1) the general peritoneal cavity cannot be drained; (2) fibrinous exudate is immediately formed around the drain which very soon walls off the other part of the general peritoneal cavity, (3) drains cause adhesions to be formed, which may cause intestinal obstruction; (4) drains do not siphon away exudate as they are soon plugged up.

Should the peritoneal cavity be drained? Or should the peritoneal cavity be closed and a drain placed down to the peritoneum as suggested by Meyer et al.[1] Should no drain be inserted?

Of the nineteen deaths reported in Table II, in ten cases the peritoneal cavity was drained. In six cases no drains were inserted into the peritoneal cavity or superficially. Of the three remaining cases, two patients died in the operating room. There was one death without operation. Postmortem revealed an appendiceal peritonitis.

The writer has had no experience with sump drains which were so recently described by Babcock.[2] It has been stated that glass and silver drains produce the least peritoneal irritation. If this is true, glass and silver drains should be used. It is the opinion of the writer that all cases of severe suppurative peritonitis with gangrenous or phlegmonous appendicitis should be drained.

Appendiceal Abscess. If a child has an appendiceal abscess, there should not be any rush to operate. In this respect we are in agreement with Norris[3] who recently reviewed 1,000 cases. The patient should be given an intravenous slow drip of nor-

mal saline and 5 per cent glucose sulfadiazine antibiotics according to the age of the patient. Vitamins B and C should be given also. Nothing is given orally and the condition should be watched closely. If the temperature and pulse are gradually coming down and the general condition is improving, continue to wait. If the temperature and pulse are gradually going up and the general condition of the patient is becoming worse, the abscess should be incised and drained. If the appendix is easily delivered, an appendectomy is done at the same time but if the appendix is difficult to deliver, only incision and drainage should be done. A modified McBurney incision should be made far out near the anteriosuperior iliac spine and when the peritoneum has been reached, a size 18 to 20 aspirating needle will assist in direct entrance of the abscess without contaminating the general peritoneal cavity. After the abscess cavity is thoroughly aspirated a cigarette drain is inserted down to the bottom of the cavity. The peritoneum and fascia is then closed loosely around the drain, after which the skin is closed with cotton or silk. Another method is to close the peritoneum loosely around the drain and pack the fascia and skin with idioform gauze. Now that penicillin and sulfa drugs are freely at our disposal, this type of treatment is not necessary and simply prolongs the period of morbidity.

General Management of Peritonitis of Several Days' Duration. If a child has been admitted with the history of having been vomiting for several days with high temperature, rapid pulse and dry tongue, with all signs of hemoconcentration, it is better to defer operation for a few hours, if necessary, in order to bring the patient back into the realm of fluid balance. In this way operating room deaths may be avoided and the patient will withstand the surgical procedure much better. The question of whether to operate if the patient has general peritonitis should be discussed.

Very recently a two year old, male, Italian boy was admitted to our Pediatric Service with the diagnosis of bronchopneumonia. It was thought at first that the abdominal signs were referred signs from the chest condition. The abdomen was rigid, tender, direct, rebound and crossed rebound, temperature was 103.4°F. and pulse was 140. The patient was seen in consultation with a visiting member of the Pediatric Staff at 4 P.M. The Pediatric Service did not think that the patient should be operated upon. The white blood count at that time was 14,000 with 82 per cent polymorphonuclear leukocytes and 18 per cent lymphocytes. The patient was given 50,000 units of penicillin and sulfadiazine every three hours. A cut-down intravenous drip of normal saline and glucose was given. It was decided to observe and treat the patient conservatively until 9:30 P.M. At that time there was an increase in the white cell count and a further elevation in temperature and pulse so it was decided to operate. At operation a ruptured appendix with diffuse peritonitis was found. The abdominal cavity was sucked out thoroughly and the wound was closed in layers, with drainage of the peritoneal cavity. The patient had an uneventful recovery.

One might argue that since we have at our command sulfonamides and antibiotics, conservatism is the treatment of choice in cases in which there is an appendiceal peritonitis of several days' duration. However, by the same token it might be said that one should be courageous with such an addition to the armamentarium in the treatment of very severe peritonitis.

Morbidity. There were twenty-seven patients who remained in the hospital longer than thirty days. Most of these patients were operated upon before early postoperative ambulation was advocated and also before the free use of penicillin and sulfa drugs. Of these twenty-seven patients twenty-two were operated upon before 1940. There were only two patients operated upon within twenty-four hours after the onset of symptoms who stayed in the hospital longer than thirty days. One patient continued to run a septic temperature, the cause of which was not determined. Severe bronchitis, which persisted, developed in the other patient. It is be-

lieved that had there been free use of antibiotics and sulfonamides, this morbidity would have been much less. However, we wish to emphasize the fact that penicillin and sulfa cannot supplant good, early surgery.

Mortality. A high mortality rate has been reported in this paper. Norris[3] reports a mortality of 3.2 per cent for all cases and a mortality of 10.76 per cent in appendicitis with perforation. Says he, "The only conclusion that seems warranted in this group is that after nine years of age the children have a somewhat better chance of recovery than do those below the age of nine." When the age limits from one and a half to ten years is considered, it is certain that this entire group of patients falls within the dangerous age limits and the mortality is expected to be higher than when the age limit ranges up to fifteen or sixteen years. In other words, the younger the patient the less chance of recovery.

Scott and Ware[4] report a mortality of 1.58 per cent in 506 cases, with ages ranging up to sixteen years and a mortality of 6.2 per cent in children under four years of age. They report, "This is without question the age group in which early diagnosis is most difficult. (They are speaking of cases in which age limits range from one to sixteen years.) It is interesting to note that in children under six years of age perforation was encountered more than twice as often as was simple acute appendicitis without rupture. All our patients under two years of age had perforated appendices, with the simple exception of an 11 months old boy who was operated upon within 24 hours after the onset of symptoms."

Allen[5] reviews 273 cases from the Children's Surgical Service of Bellevue Hospital from 1936 to 1940 and reports a death rate of 1.7 per cent for all cases. In a previous report made earlier he reports a death rate of 5.8 per cent for all cases. His upper age limit was much higher than the age limit in this article.

When Table II is compared with Table I, an interesting percentage of deaths is revealed. The death rate percentage is in inverse proportion to the age. The younger the patient the less frequent is appendicitis and the higher the mortality,

Fig. 1. Mortality per cent.

while in the older age group the disease is more frequent. This high mortality rate may be explained also because of the difficulty in diagnosis. In the ages from birth to two years there were nine patients admitted with four deaths, a mortality of 44.44 per cent. In patients from two to

TABLE II

Age	Deaths
0–2	4
2–4	3
4–6	8
6–8	2
8–10	2

ten years of age the mortality drops rapidly; from two to four, 37.5 per cent; from four to six, 21.16 per cent; from six to eight there were fifty-seven cases with a mortality of 3.33 per cent and from eight to ten there were eighty-three cases with two deaths, a mortality of 2.4 per cent. The mortality rate of the entire series was 9.8 per cent. If we were to eliminate the

four patients who died in the operating room, it would have been 7.33 per cent. (Fig. 1.)

There were thirteen deaths from peritonitis. Four patients died in the operating room during or just after the operation
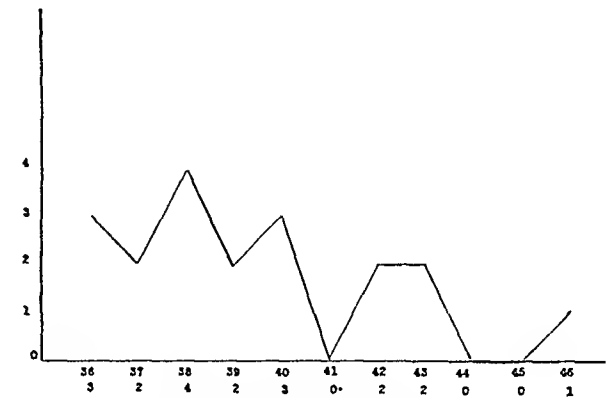
Fig. 2. Entire mortality in years.

was finished. Three of these deaths were due to the marked debilitated condition of the patients and the anesthesia. One was ill an unknown length of time before admission. One was ill five days and one four days before admission to the hospital. The fourth death which occurred in the operating room may be attributed to the anesthesia solely as the patient was ill only one day before admission to the hospital and the microscopic diagnosis was acute diffuse appendicitis. One patient, who had been ill two days before admission, died of postoperative bronchopneumonia and atelectasis. Another patient, ill only thirty hours before admission to the hospital, bled from the operative wound. Apparently there were some operative difficulties as it was noted that a tear in the serosa of the cecum had to be repaired. (Fig. 2.)

Final Word on Mortality. One of the greatest causes of mortality is due to delay in hospitalization. Only in one case was the local private physician in error. There were also delays in the hospital which contributed to mortality and morbidity. With the use of the sulfa drugs and improvement in the pre- and post operative care there has been a decline in mortality since 1938. The free use of sulfa drugs was

started in 1938, and the free use of penicillin in late 1945. Reduced mortality and morbidity rates are now clearly in evidence.

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SCHAEFER and Erbes studied the records of some 250 patients with hypertrophic pyloric stenosis admitted to a children's hospital. They believe that x-rays should be used more often, especially to diagnose questionable cases. Visible peristaltic waves were present in over 80 per cent of the cases. The first-born child is more apt to develop this condition than the others, especially if it is a male. Apparently negroes are relatively immune. The Fredet-Rammstedt type of operation was done almost universally. The postoperative mortality in this series was about 15 per cent up until ten years ago. Since then 172 infants have undergone this operation without a single death. Almost three-quarters of these patients varied in age from three to six weeks. In hypertrophic pyloric stenosis the longitudinal muscle fibers are also involved as proven by biopsy specimens taken at time of operation. Formerly we believed that only the circular muscle fibers were hypertrophied. Early diagnosis and better preoperative care have reduced the hazards of this operation to nil. (*Richard A. Leonardo, M.D.*)

CARCINOMA OF COLON PRODUCING ACUTE INTESTINAL OBSTRUCTION DURING PREGNANCY

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AFTER a diligent search of the literature we are confident that we are presenting the first case of a patient who has fully recovered from resection of sigmoid colon following acute intestinal obstruction produced by carcinoma of the colon during pregnancy. The mother and child are living and are in excellent health nineteen months following resection of the sigmoid and fourteen months following delivery.

In substantiation of this statement we note that in 1940 Der Brucke[1] stated that in the last century only five authenticated reports of malignancy of the bowel tract complicating pregnancy have appeared in the literature. He added two cases. Der Brucke's first case was that of a twenty-three year old primipara in whom obstruction developed. She was given medical induction and delivered a live infant. This was followed by laparotomy and exteriorization of the sigmoid carcinoma. The mother died postoperatively. Der Brucke's second patient was a gravid, thirty-six year old woman with obstruction. A laparotomy and cecostomy precipitated labor. She had carcinoma of the sigmoid colon with omental metastases. The patient died two months after the laparotomy from cachexia and terminal bronchopneumonia without benefit of further surgery. Der Brucke summarized the five known cases reported in the literature from 1879 to 1940. The records were incomplete but they revealed that three mothers died before leaving the hospital and one soon after. Two of the infants survived.

In 1945 Finn and Lord[2] made an exhaustive study of textbooks and medical literature on the subject of carcinoma of the colon producing intestinal obstruction during pregnancy. They reported that their pregnant patient was the first and only one to survive resection of the sigmoid colon and, subsequently, to deliver a live infant. Their thirty-one year old multipara was six months pregnant in June, 1944, when they performed the first operation, a transverse colostomy, for release of a mechanical obstruction. Two weeks later the sigmoid was resected. In July, 1944, the colostomy was closed. The patient made an uneventful recovery from these surgical procedures and had a normal vaginal delivery at term. Correspondence from both authors reveals that the mother died in November, 1945, from carcinomatosis following multiple operations. The baby was well up to six months of age and no mention is made of it thereafter. A re-examination of the literature confirms the claim of Finn and Lord. Unfortunately their patient had metastatic extension of the colon carcinoma at the time of the first operation.

The Lahey Clinic[3] reported a surgical technical problem in which the colon was resected successfully for ulcerative colitis during pregnancy. The surgical problem was similar to ours and equally as difficult but the prognosis of colitis is considerably better than for carcinoma and in the Lahey case much of the timing was left to the surgeon. Furthermore, there was no problem of acute intestinal obstruction which was one of the three components of our problem. The Lahey clinic patient had a divided ileostomy in February, 1946. She had subsequent marked improvement and became pregnant several months

later. A partial colectomy was successfully performed when the patient was about four months pregnant. The mother and infant were well at delivery in August, 1947. The remainder of the colon and rectum were removed in November, 1947. The patient made an uneventful recovery.

Kotz and Kasper[4] reported fourteen cases from the Vienna Clinics. These fourteen cases of rectal carcinoma complicating pregnancy were operated on by the sacral route only and all patients died. Maxwell and Wong,[5] working in a large hospital in China, made an exhaustive study of intestinal obstruction complicating pregnancy. They listed volvulus, intussusception, ileus, adhesions, bands, ovarian cysts, pelvic disorder and other causes of intestinal obstruction but they reported no cases of intestinal carcinoma causing obstruction. Evers,[6] Mengert[7] and Fourier[8] each reported a case of carcinoma of the colon complicating pregnancy. All three mothers died from peritonitis without resection of the colon. Two developed peritonitis following perforation of the carcinoma and the third had generalized metastases. Kynoch[9] reported a case of intestinal carcinoma complicating pregnancy in a girl twenty-one years of age. Both mother and infant died. Kynoch reviewed the German literature and found no survivals when carcinoma of the colon complicated the pregnancy.

Swartley et al.[10] reported the first case of perforated carcinoma of the large intestine complicating pregnancy in which both mother and child have survived. Their patient was a thirty-nine year old primipara with acute perforation of carcinoma in the rectosigmoid colon complicating a seven and a half months' pregnancy. In October, 1945, they did a classical cesarean section and delivered an infant weighing 5½ pounds. This was immediately followed by a subtotal hysterectomy, left salpingo-oophorectomy and a permanent colostomy. In December, 1945, an abdominal perineal resection for rectosigmoid carcinoma was performed.

The postoperative course was uneventful. Recent information on this patient revealed that she has pelvic metastasis for which she has received roentgen therapy. This was the first successfully treated patient in whom the components were carcinoma of the large intestine, perforation of the carcinoma and pregnancy. In the case presented herein the components are carcinoma of the large intestine, acute obstruction caused by the carcinoma and pregnancy.

Banner, Hunt and Dixon[1] reviewed most of the world literature on intestinal carcinoma complicating pregnancy and reported a total of sixty-two cases. This series includes carcinoma from all portions of the intestine and is not limited to the colon. All diagnoses were not confirmed by autopsy or microscopic examination. Surgery was not performed in all cases. A re-examination of the literature in many of these cases revealed the records to be inadequate and incomplete as the outcome of the mother and infant was not always indicated. They reported seven cases of carcinoma of the large intestine which occurred at the time of pregnancy or prior to pregnancy which have been treated at the Mayo Clinic since 1917. There were four cases of colon carcinomas and three rectal carcinomas. All were treated by resection with a maternal mortality of 14 per cent and fetal mortality of 14 per cent. The excellent results obtained at the Mayo Clinic re-emphasize the benefits of early investigation of suspicious symptoms and early detection of carcinoma. Their cases contained only two components, carcinoma of the large intestine and rectum and pregnancy. There were no cases of acute obstruction caused by carcinoma or perforation of carcinoma.

CASE REPORT

L. D., a thirty-eight year old gravida 6, para 0, was first seen by us on August 11, 1947, with a history of amenorrhea dating from the onset of her last menses, June 10, 1947. Her menstrual history was completely normal. She had
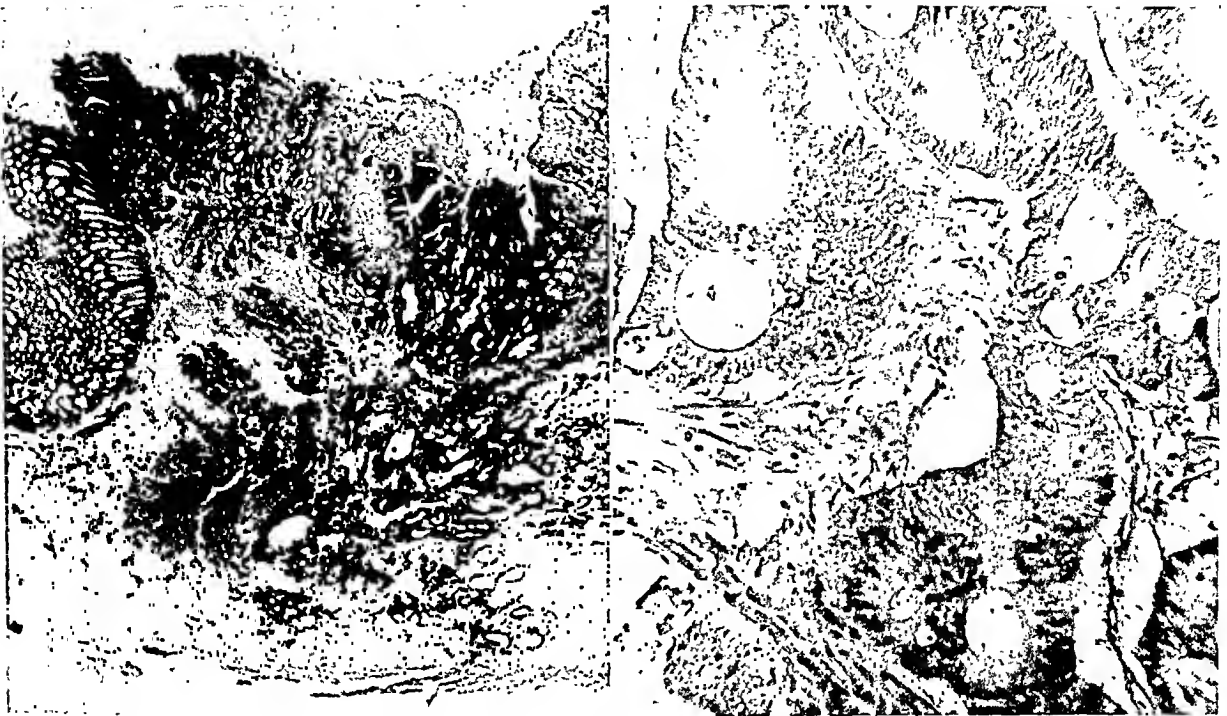
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FIG. 1. Shows a typical adenocarcinoma invading the entire thickness of the sigmoid colon wall. Some areas show a lack of pattern and other areas are well differentiated. Normal mucosa is seen on the extreme left.

FIG. 2. A section of Figure 1 under higher magnification. It shows a glandular pattern in which there is some variation of cell position and a definite loss of nuclear polarity. There is considerable pleomorphism of the nuclear elements. The mitotic figures are fairly well differentiated.

had five previous induced abortions without complications. The system review was negative except for chronic constipation over the past twenty years. Proper diet control had enabled her to maintain fairly normal bowel function. Physical examination showed her to be well nourished and well developed with no abnormal findings except a markedly retroverted uterus and a mass the size of a small lemon in the left lower quadrant. This was believed to be a cystic ovary. Her weight was 130½ pounds. Constipation of increasing severity with accompanying pains in the lower abdomen became marked in the sixteenth and seventeenth weeks of her pregnancy. Routine treatment of this condition failed to produce a satisfactory response and even colonic irrigations were of no value. When seen on October 14th, she had not had a normal bowel movement for one week. She was markedly distended and in pain. Her abdomen was tympanitic to percussion and loops of bowel were palpable through the abdominal wall. Her weight had remained unchanged, her appetite having been poor. On October 14th she was admitted to Sibley Hospital where roentgen studies showed complete obstruction at the level of the sigmoid

but failed to reveal the basic disorder. Blood pressure was 100 systolic, 60 diastolic, pulse 68 and respirations 12. On October 15, 1947, a midline subumbilical incision was made and exploration revealed that the uterus contained a four months' pregnancy. There was an annular carcinoma of the sigmoid which was causing acute intestinal obstruction. The liver was normal to palpation. A second incision was made in the McBurney region and the cecum was delivered through this incision. A catheter passed into the exteriorized cecum facilitated immediate deflation, evacuation of gas and feces and relief from the acute obstruction. This cecostomy appeared to be the safest and most direct method of accomplishing decompression. A Mikulicz exteriorization at this time carried too great a danger of infection and abortion. Primary resection was not considered because of the marked distention of the bowel proximal to the carcinoma. The patient was prepared for resection of the sigmoid by adequate decompression of the colon by means of irrigations and a Miller-Abbott tube which was introduced into the colon through the cecostomy, sulfsuxidines, streptomycin, whole blood transfusions, intravenous

fluids, vitamins and supportive care. On October 31, 1947, a left lateral rectus incision was made. A double-barrel Mikulicz type resection of the sigmoid colon containing the carcinoma was performed. Figures 1 and 2 show microscopic sections of the tissue. About 20 cm. of colon were resected between Payr clamps which were left attached to the bowel for forty-eight hours. The uterus was large and although it made for technical difficulties, they were not sufficient to recommend termination of pregnancy. Open and closed technics both side-to-side and end-to-end were considered but it was believed that they were not advisable in this patient because of the danger of infection. A pregnant uterus tolerates major abdominal surgical procedures well if there is no contamination, infection or undue surgical trauma. On November 17, 1947, the colostomy and cecostomy were closed. The pregnant patient withstood three surgical procedures for relief of acute intestinal obstruction and resection of the sigmoid without elevation of temperature or complication. On December 2, 1947, she was discharged from the hospital in good condition, ambulatory and having normal bowel movements.

Prenatal visits from the date of hospital discharge on December 2, 1947, until delivery on March 14, 1948, revealed no abnormalities. She gained weight steadily from her low of about 100 pounds while in the hospital until at term she weighed 151 pounds. Her appetite was good throughout and her bowels functioned well. She was delivered of an 8 pound 12 ounce male infant on March 14, 1948, following a perfectly normal labor of eight hours and fifty minutes. Delivery was accomplished by low forceps and episiotomy under ethylene and oxygen anesthesia and the patient was returned to her room in good condition. Her convalescence was uneventful. The five weeks check showed her weight to be 131½ pounds and her pelvis and abdomen were normal. On August 20, 1948 and again on April 15, 1949 roentgen examinations of her gastrointestinal tract revealed no abnormalities. The colon appeared normal throughout and there was a wide aperture at the site of the anastomosis. When last seen in April, 1949, she and the child continued to be very well.

COMMENTS

Modern advancements in medicine and in the field of endocrinology, improved treatment of sterility, marriage of women at an older age and procrastination of pregnancy until the third and fourth decades have increased the number of pregnancies among older women. At the same time we are seeing more malignancy in younger people. Thus we may expect a progressively increasing number of pregnancies to be complicated by malignancies.

The diagnosis of carcinoma of the colon complicating pregnancy is made particularly difficult because of its rarity and the ability of early carcinoma symptoms to mimic pregnancy. Constipation is usually present in pregnancy. Frequent laxatives may be required to give relief. This is an important diagnostic factor in carcinoma yet it may be explained away on the basis of pregnancy. There may be diarrhea alternating with constipation or diarrhea alone. Early symptoms of carcinoma, hemorrhoids and rectal prolapse of pregnancy may cause rectal bleeding, bloody mucous stools, tenesmus or rectal pain. Abdominal distention may be seen with constipation, partial or intermittent type of intestinal obstruction and with ileus as well as in carcinoma of the colon. Pain, abdominal discomfort and cramps and backache may be mistakenly attributed to the pregnancy by both patient and doctor. Nausea and vomiting during the last half of pregnancy is not commonly caused by uncomplicated pregnancy. Vomiting and abdominal discomfort are seen in pregnancy and, together with weight loss and anemia, may be accepted as symptoms of pregnancy rather than carcinoma. Pregnancy may effectively match all symptoms of the malignant character of early colon tumor, yet the careful observer may detect the difference which calls for further investigation. If there is no obstruction or rupture of the carcinoma into other viscera or into the peritoneal cavity, the malignancy may be present and undiscovered until the pregnancy is at term. Late in pregnancy the pain of carcinoma may be accepted for the onset of labor. If the carcinoma is in the rectosigmoid junction, it may first manifest

itself by dystocia. Palpation of an abdominal mass may be unsatisfactory because of the pregnancy and the bowel distention. Roentgenograms may be of diagnostic help in cases partially obstructed by neoplasms of the bowel.

Pregnant patients with symptoms suspicious of carcinoma of the intestinal tract should have careful observation. Visual and digital anal examination followed by anoscopic and sigmoidoscopic examination and by biopsy of accessible tumors should be carried out. Diagnostic roentgen studies of the intestinal tract should be made and repeated if necessary. Drastic purging should not be persisted in when constipation is prolonged. The use of the Levine, Cantor, Miller-Abbott and similar decompression tubes with accompanying suction is beneficial in partial and intermittent types of obstruction but should not be persisted in over a long period of time without knowledge of the cause of the obstruction. Such devices are helpful in preparing the patient for surgery and postoperatively. The diagnosis of carcinoma should be considered when symptoms of partial or intermittent intestinal obstruction associated with otherwise normal pregnancy become aggravated. When total occlusion of the colon occurs, surgery and diagnosis are imminent. If there is no intestinal obstruction caused by the colon malignancy, the symptoms usually are accepted as a part of the pregnancy.

Peritonitis in the pregnant woman carries with it a high maternal and fetal mortality. This peritoneal contamination, infection and peritonitis must be avoided by selecting surgical procedures which will give the greatest degree of protection to the patient. These procedures will vary with the anatomic and pathologic findings, with the term of the pregnancy and with the experience and preference of the surgeon. The best surgical management will employ means of saving both mother and child. It will not sacrifice one for the other, either child or mother. We do not concur in the recommendation of Berkeley, Bonney and MacLeod[12] to perform hysterec-

tomy, colostomy and later resection, regardless of the stage of pregnancy.

In previable pregnancy the involved segment of colon may be resected without interfering with the pregnancy. This has been accomplished by the Lahey Clinic,[3] Mayo Clinic,[1] Finn and Lord[2] and ourselves. In the viable pregnancy a cesarean section, hysterectomy and colon resection may be advisable as accomplished by Swartley et al.[10] or the fetus may be delivered from below and followed by laparotomy and resection.

In non-resectable cases an immediate colostomy and closure will relieve symptoms and permit a vaginal delivery provided the growth does not obstruct the birth canal. In final analysis, however, the precise treatment in any given case must be based upon the individual combination of symptoms and physical findings and upon the experience, preference and judgment of the surgeon and not upon any arbitrary rule.

Success in this case may be attributable to: (1) careful observation of the pregnant patient and early recognition of the complication and early surgical consultation; (2) the symptoms of carcinoma of the colon manifested themselves relatively early; the carcinoma was located in the sigmoid and not in the rectum; (3) multiple-stage surgical procedures to avoid infection, shock, thrombosis of pelvic vessels and interruption of pregnancy; (4) adequate decompression of the obstructed bowel by means of cecostomy and the use of the Miller-Abbott tube with suction; (5) restoration and maintenance of the patient's chemical balance by means of intravenous fluids including blood; adequate psychosomatic therapy; the use of antibiotics and vitamins; (6) Mikulicz exteriorization type resection of the sigmoid colon to avoid undue trauma to the viscera, infection and peritonitis; (7) recent advancements in anesthesia which facilitate good anesthesia; (8) normal delivery at term with routine episiotomy and outlet forceps; (9) close observation and follow-up studies.

CONCLUSIONS

As far as can be ascertained from the literature we believe that this is the first successful treatment of a patient who had the three components, acute intestinal obstruction, carcinoma of the colon and pregnancy. The mother and infant are well nineteen months following resection of the sigmoid colon and fourteen months following delivery.

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HYSTEROGRAM IN THE DIAGNOSIS OF UTERINE BLEEDING

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ABNORMAL uterine bleeding is a problem frequently confronting the physician. Since accurate diagnosis is complicated and often burdensome for both the patient and the physician, there is a tendency to rely upon hormone therapy which often yields gratifying results. However, the indiscriminate use of injection therapy with a multiplicity of hormones is not without danger.[1] In spite of this injection therapy for uterine bleeding is becoming increasingly popular with the physician. It is obvious that proper treatment can follow only when an accurate diagnosis is first established.

To establish an etiologic diagnosis in a case of uterine bleeding, a certain minimum of office procedure is required. A complete physical examination is the first essential. Careful visual and manual examination of the pelvic organs is extremely important. Simple blood studies and a basal metabolic rate and other office laboratory procedures may be indicated. After the routine physical and gynecologic examination a number of patients will fail to show any adequate cause for the bleeding. Pelvic examination may be normal or unsatisfactory because of obesity, tenderness or voluntary or involuntary spasm. Some of these patients are investigated further with a diagnostic curettage. This procedure requires hospitalization and anesthesia, is disturbing emotionally and may be burdensome financially. It is possible that a curettage, even when properly done, may not reveal the cause of the bleeding. (Fig. 1.) It is not justifiable then, without further investigation, to attribute uterine bleeding to endocrine disturbance even when a pelvic examination fails to reveal any pathologic disorder. Because of these difficulties it was decided to investigate the possible advan-

tages and feasibility of routine hysterography in patients with uterine bleeding.

Contraindications. Hysterography is considered by many[2,3] to be contraindicated in bleeding because oil may be introduced through open sinuses or malignant cells may be diffused through the tubes into the peritoneal cavity. There have been reports[4,5] of oil emboli in the vessels of the broad ligaments and death from generalized embolization. These complications occurred as a result of using an oily radiopaque medium in the procedure.

In this study a non-oily radiopaque material is used called Rayopake. It is the diethanolamine salt of 2,4-dioxo-3-iodo-6-methyl tetrahydropyridine acetic acid, with 3½ per cent concentration of polyvinyl alcohol. No ill effects were observed in our series and none have been reported. As will be noted below, smaller amounts of radiopaque material (1.5 to 3.0 cc.) are used. This diminishes the likelihood of dissemination of emboli.[7]

The objection may be raised that profuse uterine bleeding would make the intra-uterine injection of radiopaque material impossible or untrustworthy. Experience in reading hysterograms will eliminate this error. One of our most conclusive diagnoses (Case III) was made under just such circumstances.

Contraindications to hysterography do exist. Most important of these is the presence of acute inflammation. Chronic inflammation is no deterrant since the amount of radiopaque material injected is sufficient only to outline the uterine cavity and there is little opportunity for the spread of disease through the fimbriated ends of the tubes. Bleeding in possible early pregnancy is another contraindication but there have been reports of pregnancies going to term in spite of

FIG. 1. Cornual polyps clearly demonstrated by x-ray after having escaped two previous curettings.

hysterography.[8] Since both of these conditions are easily diagnosed as a rule, the procedure described is readily applicable to all but a small number of patients.

Technic. The technic used is described by Hyams[2] and Goldberger[9] and has been modified somewhat for our purpose. The use of smaller amounts than has heretofore been advocated is stressed.

The patient does not require any special preparation since it has been found that the intestinal contents do not interfere with the procedure. A full bladder may be desirable since in one patient in our series (Fig. 5) a subserous fibroid was nicely outlined against the distended bladder.

A scout film is taken first in all cases. This is important as demonstrated in one patient who complained of sharp, right lower quadrant pain during the procedure. A shadow interpreted (and later verified) as an appendiceal calculus was found. A film is taken after 1.5 cc. and after 3.0 cc. have been injected into the uterus. Only in an exceptionally large uterus are 5.0 cc. used.

Further refinements in the technic are

the use of radiolucent plastic bivalve vaginal speculum and a uterine sound marker.[10] This speculum eliminates the dense metallic shadow which might obscure pathologic shadows in the cervix or those caused by a markedly displaced uterus. Use of the sound marker in conjunction with the standard uterine sound gives a rapid and accurate measurement of the depth of the uterine cavity. This is important in determining the total amount of radiopaque material injected.

One hundred four consecutive cases of uterine bleeding with normal or obscure examinations are considered in this report. Of these twenty-four patients failed to reveal any evidence of a pathologic condition with this procedure. Thirty-four patients had endometrial polyps. Twenty-eight patients had fibroids of the uterus and eleven had hypertrophic endometritis. There was one case of missed abortion and a patient with cervical carcinoma invading the uterine cavity.

CASE REPORTS

The following case summaries illustrate the value of the hysterogram in revealing specific conditions:

CASE I. A. S., a fifty-two year old, white woman, stated that her menses had occurred regularly at twenty-eight-day intervals lasting four to five days and that she used three to four napkins daily. For the previous three months she had bled for seven days and had used ten napkins a day. In addition she had a brownish discharge between menses which had not been present previously. During this interval she had lost 9 pounds but otherwise was asymptomatic. Examination revealed a well developed, well nourished middle-aged woman apparently in perfect health. Her weight was 184 pounds, blood pressure 150/80, and pulse 76. All findings were normal except for the pelvic examination which revealed a polyp-like mass protruding from the cervix. The uterus was very slightly enlarged and more globular than usual. The adnexa were not palpable or tender. The protruding mass was thought to be a polyp and, therefore, was twisted off in the usual manner. The subse-
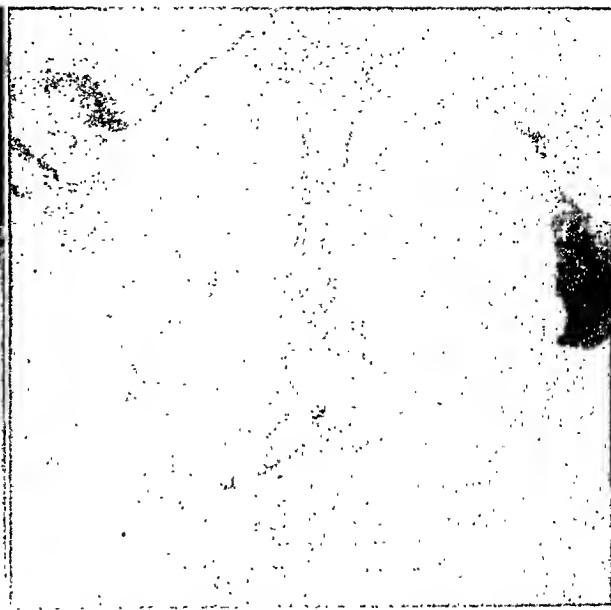
2   3

FIG. 2. Invasion of uterine cavity by cervical adenocarcinoma.
FIG. 3. Gross specimen of Case 1, showing (arrow) site of origin of radium-treated cervical adenocarcinoma.

quent pathologic report was "degenerated blood clot." At the same time, to determine whether more polyps were present, a hysterogram was done. This showed a cauliflower mass invading the uterine cavity, pathognomonic of malignancy. (Fig. 2.) A confirmatory dilatation and curettage was done immediately; radium was inserted in the uterus at the same time. After the interval prescribed by the radiotherapist, a hysterectomy was performed. Carcinoma, originating in the cervix and growing into the uterine cavity but not visible at the external os, was found. (Fig. 3.)

The interesting point of this case is the diagnosis of malignancy at the time of the original visit when one easily could have lost a great deal of valuable time by being misled by the presence of a polypoid blood clot.

CASE II. G. P., aged forty-one, whose chief complaint was menorrhagia of three months' duration, was first seen in September, 1943. A complete endocrine and physical examination including an endometrial biopsy failed to reveal a cause for bleeding. It was assumed to be premenopausal and treatment with testosterone was instituted. This controlled her bleeding over a nineteen-month period but when therapy was stopped, bleeding recurred. In February, 1945, a hysterogram was done and a submucous fibroid was found (Fig. 4)
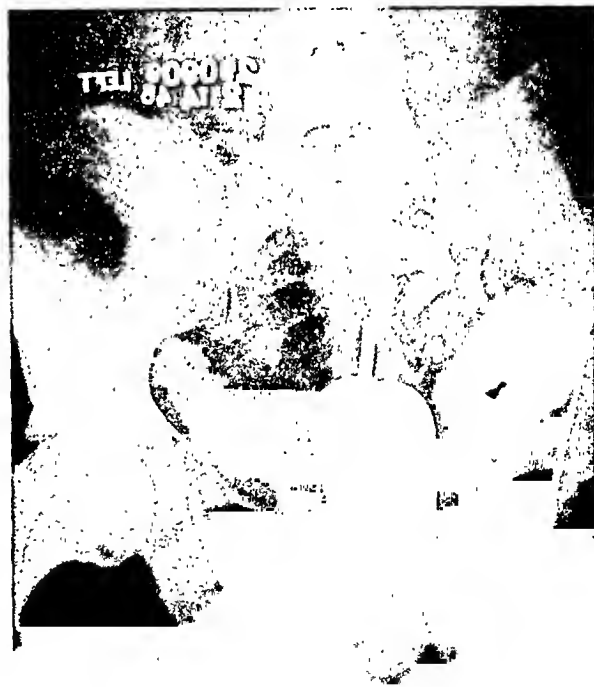
FIG. 4. Case II. Submucous fibroid in a small uterus.

which was confirmed by subsequent operation. This patient was examined at two clinics and by many competent gynecologists over a two-year period, yet a correct diagnosis was not made until routine hysterography for bleeding was done.

CASE III. E. M., a fifty-four year old woman, weighing 220 pounds, was admitted

5   6
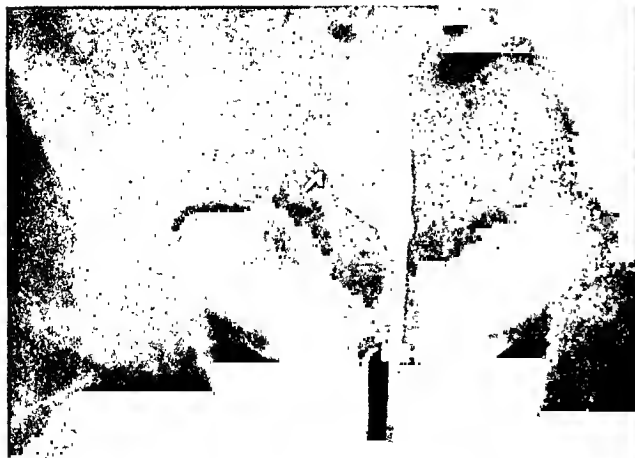
Fig. 5. Case III. Submucous fibroids (arrows).
Fig. 6. Case III. Subserous fibroid demonstrated on scout film.
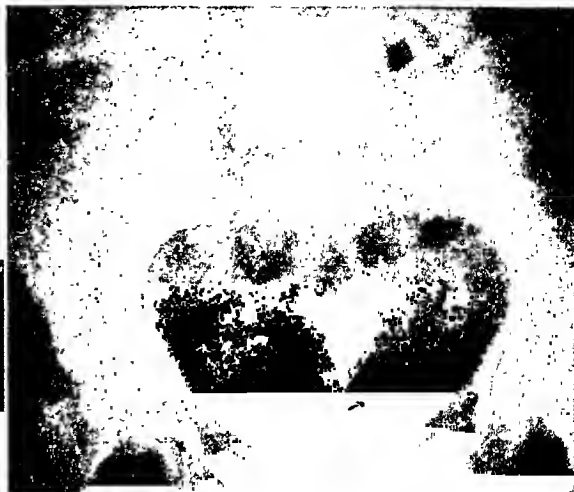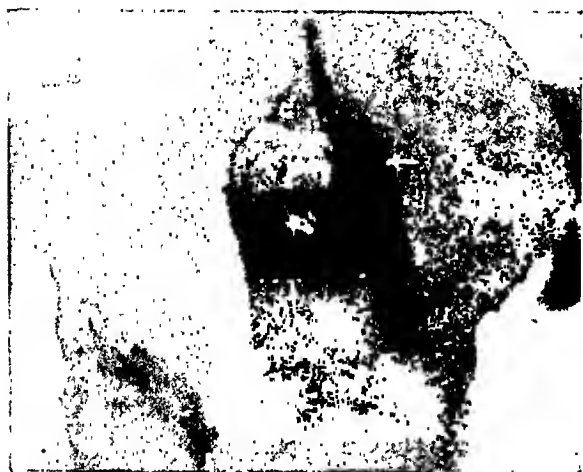
Fig. 7. Gross specimen of Case III showing (arrows) the two submucous fibroids demonstrated by x-ray in Figure 5.

to the Surgical Service of the Southside Hospital, Bay Shore, New York, with a complaint of abnormal uterine bleeding of two years' duration during which time her physician had been treating her with hormone therapy. A rather profuse hemorrhage necessitated her admission to the hospital. Gynecologic examination by three staff members was unsatisfactory because of the patient's obesity. Hysterography showed two submucous fibroids (Fig. 5) together with a large subserous fibroid which the scout film revealed. (Fig. 6.) One of the submucous fibroids clearly revealed by Figure 4, was later measured and found to be only 1/8 inch in diameter and height. The entire picture was confirmed at operation. (Fig. 7.)

The interesting feature of this case is that the ordinary methods of examination were inadequate. A diagnostic dilatation and curettage, which had been considered at the time of admission, also would have been of little value and would have subjected the patient to unnecessary delay.

CASE IV. E. M., a thirty-four year old woman, complained that for the past five months she menstruated every twenty-four days instead of her usual twenty-eight. Her periods lasted seven days and she used four napkins daily. During the past three months she had dysmenorrhea and intermenstrual bleeding. A polyp of the external os had been removed elsewhere three years before. Gynecologic examination revealed a uterus and cervix normal in size, shape and position. Adnexa were palpable but not otherwise remarkable. Hysterogram showed a number of well defined polyps. (Fig. 8.) This was confirmed by subsequent dilatation and curettage and films taken one week later confirmed the removal of all polyps. (Fig. 9.)

CASE V. E. S., a twenty-eight year old woman, whose menses started at thirteen years of age, had regular menstrual periods between the ages of thirteen and nineteen. After this she had periods of amenorrhea for two to four months followed by periods of menometrorrhagia lasting five to six weeks. Examination revealed a hirsute, somewhat obese female. Her cervix and uterus were normal in size and shape. Laboratory findings

FIG. 8. Case IV. Multiple uterine polyps.
FIG. 9. Post-currettage hysterogram of Case IV showing normal uterine contour.
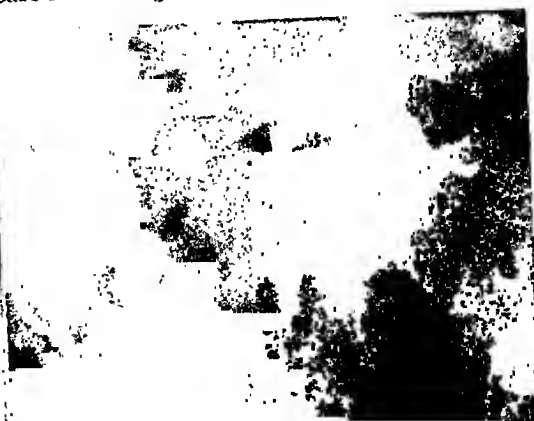
FIG. 10. Case VII. Multiple endometrial polyps due to follicle cystosis.
FIG. 11. Case VI. Missed abortion demonstrated by x-ray.

were as follows: basal metabolic rate was minus 6, serial vaginal smears and vaginal pH were normal, follicle-stimulating hormone excretion was negative, and urine estrone excretion varied between 16 to 30 rat units per L. on different occasions. Urine androsterone studies varied between 3 to 7 mg. per day at different times.

The patient was treated with various forms of endocrine therapy including large doses of estrogens with temporary relief. She received up to 300 mg. of androgen per month, with complete cessation of bleeding. One and a half years later the patient suddenly developed a profuse menometrorrhagia. A hysterogram done at this time was interpreted as multiple endometrial polyps. (Fig. 10.)

A laporatomy was done and the ovaries

showed bilateral follicle cystosis. Both ovaries were partially decapsulated and a wedge was removed from each. Abdominal hysterotomy revealed profuse, generalized polyposis of the endometrium. Since this procedure the patient's menstrual cycle has been normal.

CASE VI. This patient was seen three months before examination by a hematologist to whom she had been referred because of uterine bleeding for which no cause could be found. His study revealed a normal blood picture and the patient was then referred for treatment of menometrorrhagia.

History revealed that at the onset of the patient's complaint there was a delayed menstrual period of two weeks followed by two months of irregular bleeding. Examination revealed a slightly enlarged uterus. Two Aschheim-Zondek tests were reported negative. A hysterogram was done (Fig. 11) and a missed abortion was found. The patient continued in this manner six weeks at the end of which time she had an episode of cramps and bleeding and passed a small macerated fetus.

SUMMARY AND CONCLUSIONS

1. The use of an innocuous radiopaque medium in hysterography for uterine bleeding is discussed.

2. The use of this procedure in this series of 104 patients with obscure uterine bleeding revealed a pathologic cause in the uterus in seventy-eight instances, or approximately 75 per cent of the cases.

3. The technic as modified renders the procedure simple and with little or no reaction.

4. In view of these findings it is believed that this procedure is an important diagnostic adjunct in all cases in which clinical examination has failed to reveal the cause of uterine bleeding.

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ENDOMETRIOSIS OF THE CERVIX UTERI*

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ONE of the more uncommon locations for the occurrence of endometriosis is on the cervix uteri. The relatively few reports in the literature of this entity are ample evidence of its rarity.

Endometriosis of the cervix uteri has been classified into primary and secondary types on a pathogenetic basis. It has been stressed repeatedly that only those cases in which there has been direct extension of the endometrium, or primary transplantation of endometrial tissue on the mucosal side of the cervix, should be considered as primary endometriosis of the cervix, and that other cases reported as such are in reality either extensions from rectovaginal involvement from transplants on the posterior surface of the supravaginal portion of the cervix or cystically dilated cervical glands found deep in the fibromuscular stroma of the cervix. Examination of the pelvis at laparotomy and pathologic study of the complete uterus are the only means of certain exclusion of secondary involvement of the cervix.

Lash and Rappaport[1] made an extensive search of the literature and were able to locate five case reports of so-called primary endometriosis of the cervix uteri. To these they added one of their own.

REVIEW OF CASES

The case reported by Fels[2] occurred in an unmarried nullipara aged thirty-three years whose complaints when first seen were vaginal discharge and pain in the right lower quadrant. Anterior fixation of the retroflexed uterus and appendectomy were performed. No evidence of pelvic endometriosis was found at operation. The pain persisted. Pelvic examination four months later showed three dark red nodules each 4 mm. in diameter on the left side of the cervix; in addition a scar was noted extending from the cervix to the left side of the vaginal vault. Neither of these findings had been present at the first examination. There was nothing in the history to suggest the etiology of the scar. Pathologic examination of the nodules showed endometriosis. The patient refused additional surgery although the author suspected the presence of adenomyosis of the uterus.

Rushmore[3] wrote of a twenty-six year old female who had been delivered four years previously by version and extraction of a full-term infant and two years later had an appendectomy and right salpingectomy. At the first visit she complained of a little brownish vaginal discharge of one week's duration which had started two days after menstruation was due, and some discomfort in the right side of the abdomen just under the ribs for the same period. Examination did not suggest pregnancy and upon inspection of the cervix a small polypoid nodule about $\frac{1}{4}$ inch in diameter was found attached to the portio vaginalis to the right of the external os. There was a slight amount of dark brownish fluid discharging from the lesion. Pathologic report of the excised nodule was endometrial transplant (pregnancy). The patient returned in two and one-half weeks because of continuation of the discharge. Pelvic examination at this time showed dark blood-stained fluid in the vagina, and the growth on the cervix two to three times larger than before the first removal which was bleeding slightly. Laparotomy performed one week later because of suspected extrauterine pregnancy and uterine malignancy revealed an intrauterine gestation but no evidence of pelvic endometriosis.

Fobe's[4] case was a twenty-three year old nullipara who was in the third month of pregnancy and who complained of brownish vaginal discharge. Her past history revealed that after two years of marriage she visited a physician for dysmenorrhea and sterility. Curettage and round ligament shortening were performed for retroversion. She became pregnant shortly thereafter but aborted in the third month. Her present complaint began about one year following the abortion. Examination showed a small, hazel-nut sized elevation on the anterior cervical lip. Microscopic diagnosis of the excised lesion was endometrioma with decidual reaction. Delivery at term was uneventful.

Hobbs and Lazar[5] added the case of a forty year old white female who was admitted to the hospital because of irregular vaginal bleeding, pain in the lower abdomen and backache for about two years. She had two full-term normal deliveries, twelve and fourteen years previously, and several years following the last pregnancy uterine suspension with left salpingo-oophorectomy and right salpingectomy were performed. Pelvic examination revealed a chronic cystic cervicitis with an irregular and enlarged corpus. No evidence of pelvic endometriosis was discovered at laparotomy and total hysterectomy was done. Gross examination of the specimen showed the portio covered by an intact epithelium. The cervical canal was normal except for a small, brown, papillary area, 0.5 cm. in diameter, near the external os on the right side. Histologic examination of the lesion showed endometriosis. Study of multiple sections from the uterine wall and the posterior portion of the cervix did not disclose any evidence of endometrial tissue.

Henriques[6] reported a forty year old para ix who had a sudden, severe vaginal hemorrhage during her menses. Menstruation had been normal until her last pregnancy eight years previously when she developed dysmenorrhea. Examination showed dark red, partly clotted blood covering the vulva. There was a soft, bleeding, red mass about the size of a hen's egg on the vaginal portion of the cervix. Biopsy was done because of suspected malignancy but the histologic report revealed a hyperplastic endometrial growth. The cervix was amputated and the patient made an uncomplicated recovery. No abnormalities were noted during an eighteen month follow-up period.

Lash and Rappaport[1] described a thirty-one year old multipara who developed prolonged menstruation with clots following an induced abortion seven years previously. Vaginal examination revealed a red area about 1 cm. in diameter on the anterior cervical lip about 2 cm. from the external os. She was seen four years later complaining of backache during menstruation and spotting following the menses for the past three years. Examination at this time showed a dark red, hemorrhagic, slightly elevated, pea-sized area on the anterior cervical lip. Because of the suspicion of malignancy, the lesion was excised and the uterine cavity curetted. Pathologic examination revealed endometriosis of the cervix. Recovery was uneventful and eighteen months later there were no complaints. The menses were normal.

COMMENT

Lash and Rappaport[1] on the basis of available clinical and pathologic data set forth the following criteria to be used in favor of the diagnosis of primary endometriosis of the cervix: (1) Localization of the lesion on the anterior cervical lip or to the right or left of the external os; (2) the presence of endometrial islands in the most superficial areas of the vaginal portion, immediately beneath the squamous cell epithelium or directly exposed to the surface; (3) the presence of endometrial islands within the scar tissue; (4) the absence of clinical evidence of endometriosis of the uterus or rectovaginal septum; and (5) cessation of the clinical symptoms after excision of the lesion.

The extent of involvement in pelvic en-
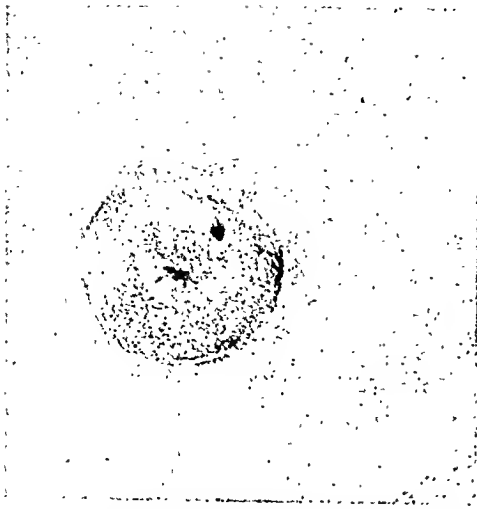
FIG. 1. The illustration shows the minute endometrial implant on the anterior lip of the cervix.

FIG. 2. Camera lucida drawing demonstrating the superficial location of the island of tissue composed of glands and stroma characteristic of the endometrium.

dometriosis may vary considerably and the presence of a primary implant on one location does not exclude the possibility of primary implants to other sites. The patient who shows a primary endometrial lesion on the cervix may also have had retrograde spill through the fallopian tubes, with primary implants to other organs such as the ovaries. Conversely, a patient with pelvic endometriosis may have in addition an endometrial lesion on the cervix. If associated, there is involvement of the rectovaginal septum or serosal surface of the supravaginal portion of the cervix, the lesion present on the cervix would be considered of secondary origin. However, if no involvement of these neighboring areas is detected and the lesion found on the cervix fulfills other criteria, primary endometriosis of the cervix cannot be excluded even though there is evidence of endometriosis elsewhere in the pelvis.

Careful inspection of the cervix should be performed in all cases presenting clinical evidence of pelvic endometriosis, and all suspicious lesions should be biopsied for the possible existence of endometrial involvement of the cervix whether of primary or secondary origin. Any patient who has proven endometriosis of the cervix should be thoroughly investigated for the presence of endometrial lesions in other locations.

June, 1949

CASE REPORT

J. S., a twenty-two year old white nullipara, married five years, was first seen on September 14, 1946, for pain in the lower abdomen and back, and sterility. The pain began about one week before the onset of each menstrual period, became marked during the first two days of menstruation and then persisted as soreness for several days. On direct questioning the patient admitted dysparcunia and pain on defecation during the menses. Fourteen months previously she had a curettage without relief of her symptoms.

Pelvic examination revealed extreme tenderness in the cul-de-sac although no nodules were palpated or seen. On inspection of the cervix a minute, hemorrhagic, cyst-like lesion about 0.3 cm. in diameter was found on the anterior lip 1 cm. from the external os. (Fig. 1.) A tentative diagnosis of pelvic endometriosis was entertained and the lesion on the cervix was suspected of being an endometrial implant. The patient was treated with 25 mg. of testosterone propionate parenterally every few days to determine if this therapy would reduce the size of the lesion.

On October 31, 1946, after a total of ten injections, the patient noted about 75 per cent improvement in her symptoms. Examination at this time showed tenderness in the left adnexa with some fullness and induration. The blood-cyst on the cervix had not changed in size and the lesion was biopsied.

Microscopically, the specimen (Fig. 2) consisted of a small fragment from the portio of the cervix uteri. The fragment was partly covered by a squamous cell epithelial lining which was intact except for one area. Here

was found a little island of tissue which produced a minute interruption of the mucosa. The island was superficially located and extended for a very short distance into the substance of the cervix. It was composed of glands and stroma characteristic of the endometrium. The glands were numerous, test tube-like in arrangement and lined by cuboidal epithelium. The cervical stroma immediately adjacent to the endometrial island showed a moderate infiltration of round cells. There was minimal lymphocytic infiltration throughout the rest of the fragment. A single cervical gland was present near the endometrial island.

The pathologic diagnosis was endometrial implant on the surface of the section of the portio.

On November 25, 1946, three 75 mg. pellets of testosterone* were implanted subcutaneously. Improvement continued and after five months there was only minimal development of untoward symptoms. Hoarseness was slight, the clitoris was one and one-half times the original size, there was no acne, very little hair growth and libido was much enhanced.

The patient was seen again on September 5, 1947. She stated that the pain had returned, and was particularly severe during her last menstrual period. Her sexual desire was decreasing although still at a higher level than before treatment. Because of the persistence of hoarseness and sore throat, it was believed that further testosterone therapy was contraindicated. At this time four 50 mg. pellets of progesterone were implanted. There was alleviation of pain during the following six months although the patient admitted that relief was not nearly so good as that following testosterone therapy.

The superficial position of the lesion, its location on the anterior cervical lip and the presence of the endometrial island directly exposed to the surface strongly suggested that this was primary implantation of endometrial tissue on the vaginal portion of the cervix. Clinically, this patient demonstrated the existence of pelvic endometriosis although the diagnosis has not been established definitely. There was no real evidence of involvement of the rectovaginal septum or the serosal surface of the supra-

* The testosterone pellets employed were supplied by Schering Corporation as Oreton-F.

vaginal portion of the cervix, but secondary extension from either of these areas cannot be excluded as only a small portion of the cervix was examined microscopically. However, as Lash and Rappaport[1] pointed out, these secondary extensions are usually on the posterior cervical lip.

If the lesion on the cervix is the cause of the patient's complaints, total extirpation of this entity will bring about the cessation of symptoms. However, if endometrial transplants exist in other areas and are the source of symptoms, removal of the cervical endometriosis alone will not afford relief to the patient. In our case the endometrial lesions in the pelvis were considered as the cause of the pain. It was not expected that removal of the cervical lesion alone would relieve her symptoms.

Attempts have been made to explain the infrequent occurrence of primary endometriosis of the cervix in spite of ample opportunity for transplantation to occur. The cervix is ideally situated for implantation since at each menstrual period endometrial fragments pass over the intact cervical mucous membrane. The mucosa apparently serves as a barrier; however, the cervix itself must be inimical to the growth of this tissue, as the intact epithelium is frequently interrupted by injury incurred during abortion, parturition and various surgical procedures. It is possible that hormonal stimulation produces changes which prepare a nidus for the implantation of endometrial fragments and that the cervix is more resistant to these changes than the other organs. Hobbs and Lazar suggested that a change in pH may be a factor in inhibiting the growth of endometrial tissue in the cervix. Lash and Rappaport stated that three factors sufficiently explained the relative rarity of primary endometriosis of the cervix: the absence of sterile conditions as found in the peritoneal cavity; the resistance of the intact squamous epithelium to implantation; and the frequent presence of some degree of infection in cervical erosions and lacerations.

It would appear that a traumatic lesion is a sine qua non for the grafting of the endometrial or decidual fragments on the cervix. In the cases reported, except that by Fels,[*] one factor stands out as being common to all. Trauma to the cervix caused by delivery or operative interference preceded the occurrence of the cervical endometriosis. It is likely in our case that during curettage some of the endometrial fragments became implanted on the cervix which had been traumatized by the dilatation.

SUMMARY

A presumptive case of so-called primary endometriosis of the cervix uteri is reported. This lesion is uncommon. Its rarity is explained by the intact squamous epithelial barrier, the resistance of the cervix to changes produced by possible hormone dysfunction, the hostility of the cervix to endometrial transplants and growth, the presence of some degree of infection and a change in pH. It appears that trauma to the cervix is a necessary prerequisite for the implantation of the endometrial or decidual fragments.

Thorough search of the pelvis for endometrial lesions should be performed when endometriosis of the cervix is found, and careful examination of the cervix for the presence of endometrial implants made in all cases of pelvic endometriosis.

Androgen therapy in the form of testosterone propionate and testosterone pellet implantation afforded excellent relief of pelvic pain. Moderate alleviation of the syndrome followed progesterone pellet implantation.

[*] The presence of the scar on the cervix in this case suggested some previous injury.

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CERVICAL STUMP IN SUBTOTAL HYSTERECTOMY

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WHILE total hysterectomy is the operation of choice, subtotal hysterectomy has its place in surgery. The chief difference between the two operations is the cervical stump which is left. The following method has been used by me in the past fifty subtotal hysterectomies and has certain advantages. I have never seen this particular procedure described before.

Briefly, the surgical technic used is as follows: The cervix itself is thoroughly
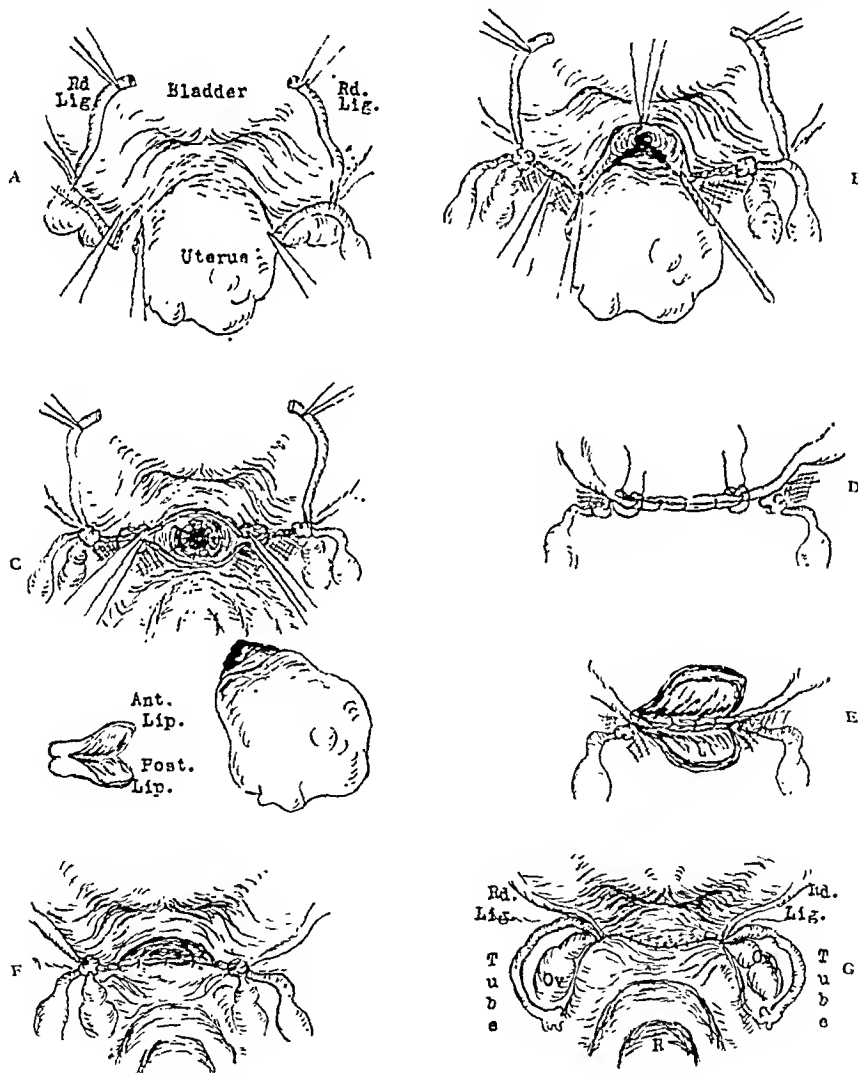
FIG. 1. A, dissection of the round ligaments from the broad ligaments beginning at the uterine attachment and extending laterally; B, reflection of the bladder and the peritoneum; C, cone-shaped resection of the uterine body and side view of the v-shaped anterior and posterior cervical lips; D, the round ligaments sutured together after overlapping them; E, the overlapped, sutured, round ligaments buried in the v-shaped groove made for them; F, the closed cervix with the buried round ligaments running between the anterior and posterior lips; G, all raw surfaces covered over by the usual peritonization.

cauterized with a point electric cautery, destroying the epithelium and extending up the canal. After the intestines are packed away with gauze strips the uterus is grasped with a vulsellum through a midline incision. The round ligaments are dissected from the broad ligaments beginning at the uterine attachment and extending laterally. Plain catgut ties are placed on each end of the freed round ligament. The broad ligaments are clamped and cut, including or excluding the ovaries and tubes as deemed advisable. The peritoneum and bladder are dissected away from the anterior surface of the uterus. The body and the neck of the uterus are resected from the cervix by a v-shaped incision. The round ligaments· are then united to each other by overlapping them at a point as far lateral as is deemed necessary. This union of the round ligaments is further strengthened by several chromic catgut ligatures placed around them. The round ligaments are placed in the groove made by the v-shaped incision in the cervix in such a way that the anterior and posterior lips can be closed over them by interrupted chromic catgut sutures. The peritoneum is then sutured over the entire raw surface, completely peritonizing it. (Fig. 1.)

ADVANTAGES OF METHOD

1. The round ligaments are attached to the cervical stump by the living tissue of the anterior and posterior lips instead of by a few catgut sutures. This makes a much more secure support and prevents sagging of the floor.

2. No strain is put on the ovarian and uterine vessels as usually occurs in the conventional method of suturing.

3. Infection through the cervical canal is prevented by completely closing it.

CONCLUSIONS

A procedure is presented which furnishes a more secure support of the cervical stump and avoids as nearly as possible those cases of prolapse of the cervix which too frequently occur. Infection is eliminated and undue tension on the ovarian and uterine vessels is avoided.

Case Reports

ACUTE INFECTIOUS DIABETIC GANGRENE

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ACUTE infectious diabetic gangrene is more than just a medical curiosity as attested by a growing literature on the subject. It is entirely unrelated to the arteriosclerosis usually associated with diabetes mellitus and gangrene. Therefore, it must be considered as an entity with clinical manifestations entirely its own and the handling of these manifestations is dependent on the understanding of the processes involved.

The purpose of this report is to present an additional case in which laboratory and pathologic reports provide an opportunity for a clearer understanding of this condition. A review of the published cases reveals that the clinical picture has been noted only casually in the past and scientific data have been either scant or lacking. Acute infectious diabetic gangrene presents some interesting features regarding differential diagnosis, prognosis, complications and treatment.

CASE REPORT

A. J., a white, fifty-five year old housewife, Case No. 27515, was admitted to Mercy Hospital, Rockville Centre, Long Island, New York, on my private service on October 28, 1944, and discharged on November 14, 1944. She was re-admitted for operation on November 20, 1944, and finally discharged on December 17, 1944.

About three weeks before coming to my office she had noted a sore spot on the ball of her right foot. A short time later this became a "hole." She treated this herself with salves and ointments and finally sought advice because it would not heal. A punched-out ulcer about $\frac{1}{4}$ inch in diameter was present on the ball of the right foot. It was rather deep but its

true depth was not determined. No infection or swelling surrounded the ulcer. A urinalysis was done immediately which showed 4 plus sugar. A Wassermann test taken at this time proved to be negative. Immediate hospitalization was advised but was refused. She was told to go home and stay off her feet. She also was given a routine diet of F60, P60, C120 and asked to send her urine in daily to be checked.

She was not seen nor heard from for a week at which time she *walked* into the office. Her temperature was 104°F. The right large toe was markedly swollen and bluish in color and a large bulla was on the medial aspect. The ulcer on the ball of the foot was the size of a dime and discharging pus. There were surrounding cellulitis and edema. The dorsalis pedis and posterior tibial arteries were full and bounding. She now consented to be hospitalized.

The patient was given 20,000 units of penicillin intramuscularly every three hours and in twenty-four hours her temperature became normal and remained there for the rest of her stay in the hospital. Local wet dressings were applied constantly to her foot. Shortly after admission about two-thirds of the skin on the medial aspect of her right large toe developed a sharply demarcated area of dry gangrene. Although the surrounding cellulitis was considerably diminished and there was minimal drainage of pus from the opening on the ball of her foot, the big toe felt somewhat boggy. The gangrene of the skin progressed and finally the upper angle separated and a small amount of thin pus was seen to drain from this area.

Oscillometric readings taken above the ankles revealed excellent circulation, as follows: right foot, 4 units; left foot, 3 units. A culture of the pus from the toe on admission was found to contain Staphylococcus aureus and hemolytic streptococcus.

In spite of adequate drainage, insulin and diet the diabetes was difficult to control and
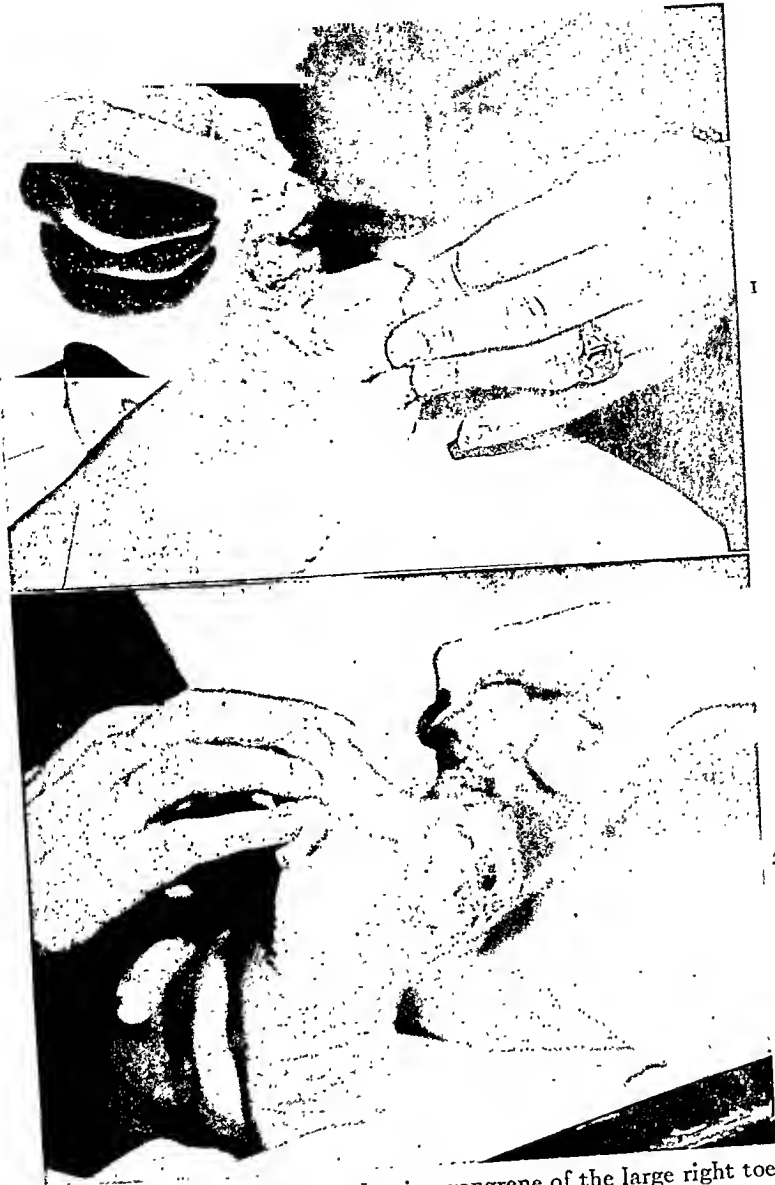
FIGS. 1 and 2. Photographs showing gangrene of the large right toe and the ulcer on the ball of the foot.

the blood sugars, taken every other day, fluctuated from 173 mg. to 307 mg. per cent while the urine specimens showed 4 plus sugar to a trace, revealing a high kidney threshold.

The blood counts taken on October 29th and November 4th were as follows:

	October 29th	November 4th
Hemoglobin 77 per cent		
Leukocytes 24,050		7,600
Neutrophiles 87		67
Lymphocytes 12		29
Monocytes 1		4

An x-ray of her right foot was taken on November 14, 1944. There was considerable rarefaction of the proxymal phalanx of the great toe with partial destruction of the

plantar cortex in the region of the head and distal shaft. The distal phalanx showed fairly marked rarefaction but no actual destruction. The findings were consistent with diabetie gangrene. There was marked soft tissue swelling of the great toe.

It was explained to her that her diabetes was uncontrollable because of the amount of infectious involvement of the tissues of her toe and amputation was advised. The patient decided to go home for a few days and then return to the hospital. She was out of the hospital for six days.

She was re-admitted on November 20, 1944, and was operated upon the following day. Local examination on admission revealed the

area of gangrenous skin on the medial surface of the large right toe. There was an ulcerated area discharging pus just above the area of gangrene and pus was being discharged from the ulcer on the ball of the foot. The entire toe and ball of the foot showed a considerable increase in cellulitis. No glands were noted in the right groin and her temperature was normal. (Figs. 1 and 2.)

Operation was performed by the orthopedic consultant whose report was as follows: Under general anesthesia a skin incision was made through the web of the right great toe. There was free bleeding. The necrotic tissue was removed on the lateral aspect of the great toe and it involved the tendons, capsule and metatarsal phalangeal joint. All necrotic skin was excised and the great toe was amputated back of the metatarsal head. All gross necrotic tissue was removed and drainage was obtained from the dorsum down through the sole of the foot. Sulfa was placed in the wound and vaseline packing was also inserted. The skin was loosely closed with one suture.

She ran a low grade temperature for ten days. For the rest of her stay her temperature was normal except for occasional spikings which were controlled by opening areas of pocketed pus in the wound. There were occasional episodes of insulin shock which were relieved by intravenous glucose and the diabetes was still found difficult to control. Blood sugars taken every other day ranged from 177 mg. to 249 mg., with the urinary sugars practically negative.

The report of the pathologist was as follows: The specimen consists of multiple irregular masses of bone, soft tissue and skin accompanied by approximately three-fourths of a great toe showing a large defect in the skin with associated hemorrhage into the underlying soft tissue. The skin in the vicinity of the nail is grossly gangrenous and one of the larger fragments of the bone structure shows an attached articulating surface. Microscopic Diagnosis shows gangrene of soft tissue with associated thromboangitis obliterans and bone showing chronic proliferative osteomyelitis.

After discharge from the hospital the patient was watched for approximately one year. Two and a half months later her foot finally healed with good epithelialization and she could walk very well with a special shoe. Her diabetes was still difficult to control. Blood sugars taken

on the average of three times a month revealed that when the patient kept to her diet and took her insulin they averaged about 110 to 130 mg. She had a low one on March 9, 1945, of 57 mg. In October, 1945, there were two blood sugars of 168 and 149. Her last blood sugar on November 15, 1945, was 220. The foot was healed perfectly. She was never seen after that.

COMMENT

Acute infectious diabetic gangrene, as seen from the tables, can attack almost any part of the body. While the majority of case reports involve the intranasal structures, accessory sinuses and hard palate, additional reports appear which show involvement of the lip, tongue, cheek, neck, skin of the entire body, lung, genital areas and toes. With the exception of lung lesions, acute infectious diabetic gangrene seems to have a predilection for body surfaces. This is understandable in view of the normal dissemination of bacteria in these areas. (Tables 1 to v.)

The diagnosis of gangrene of the intranasal structures is apparently dependent upon complaints directed toward these areas together with the observation of a foul discharge from the nose. Very frequently the first indication of intranasal involvement is a cellulitis in the areas around the bridge of the nose and under the eyelids which has been called, in several cases, erysipelas. Gangrene of the hard palate is diagnosed by direct observation of this area in the early cases only when one is aware that this condition may occur. More frequently attention is called to this area only when a foul odor to the breath is noticed or when liquids taken by mouth run through the nose. Direct observation into the nose and into the mouth will reveal blackened, gangrenous necrosis of the septum, turbinates or hard palate.

Those cases which affect the skin surfaces of the head and neck first appear as localized areas of cellulitis which quickly become reddened and in most cases appear to be true erysipelas. In two cases[1] the

TABLE I

DIABETIC GANGRENE OF THE NOSE

Author	Age (yr.)	Sex	Area Involved	Organism	Complication	Treatment	End Result
T. B. Wood. *Ann. Otol., Rhin. & Laryng.,* 46: 1112, 1937.	60	F	Nose—spreading over to cheeks; erysipelas-like lesion	....	Loss of entire nose by spontaneous amputation; loss of septum, external nose and nasal processes of superior maxilla and nasal bones	Insulin; diet; removal of gangrenous areas with thumb forceps	Alive; reconstructive surgery
K. Ardeshir. *Lancet,* 1: 1256, 1926.	8	F	Right side of nose; erysipelas-like lesion	....	Loss of right alar cartilage	Insulin; diet; removal of slough	Lived
C. H. Bowers. *J. A. M. A.,* 82: 1325, 1924.	4	?	Gangrene nasal septum; left middle and infer. turbinate, left eyelid gangrenous and black	....	Local sloughing; coma; (probable septicemia)	Diet	Died
	10	F	Gangrene nasal septum	....	Slough of nasal septum	Diet and insulin	Lived
A. G. Morris. *New York State J. Med.,* 24: 987, 1924.	58	F	Gangrene right middle turbinate	....	Spontaneous slough right middle turbinate; proptosis right eye; sinusitis right frontal and ethmoid, third, fourth; ophth. branch of 5th and 6th nerve	Diet; insulin; exeresis of frontal, ethmoid and sphenoid sinuses	Lived
E. S. Connell. *J. Mississippi M. A.,* 21: 297, 1924.	35	M	Nasal septum, perpendicular plate of the ethmoid and vomer; erysipelas-like involvement of dorsum of nose and upper lid right eye	....	Complete slough of all involved areas, perforation of hard palate.	None	Lived
S. A. Goldberg. *Arch Otolarng.,* 32: 16, 1944.	25	M	Nasal cartilage, right middle and inferior turbinate	Mixed staph. and diphtheroids	Acute osteomyelitis right orbit; removal right middle and inferior turbinate and ethmoid structures	Insulin; diet; surgical drainage of osteo	Lived
F. G. Speidel. *Kentucky M. J.,* 42: 184, 1944.	66	F	Gangrene nasal septum	....	Right ethmoiditis; right optic atrophy	Insulin; diet; removal of septum	Lived

lesion was so striking that the patients were admitted to the ward of the contagious division of the hospital. In other cases in which erysipelas is not mentioned specifically the description might very well be likened to erysipelas. Very rapidly

undermined edges. This does not occur in acute infectious diabetic gangrene of the skin.

In all of the cases of acute infectious diabetic gangrene in which cultures have been taken, the staphlococcus organism

TABLE II

DIABETIC GANGRENE OF THE GENITALS

Author	Age (yr.)	Sex	Area Involved	Organ-ism	Complications	Treatment	End Result
W. W. Elkin. J. A. M. A., 102: 2182, 1934.	42	F	Gangrene both labia majora; spreading gangrene ischial regions both sides	Staph.	None	Removal of slough	Lived
T. M. Townsend and W. M. Flagg. J. Urol., 40:464, 1938.	76	M	Necrotic penile meatus gangrene glans penis about meatus	......	Distal 2 inches of meatus sloughed and healed as a fibrous cord	Insulin; promomotion of drainage; suprapubic cystotomy	Lived

these areas became gangrenous *en masse* with a sharply demarcated border. There may or may not be several areas where small bullae appear which contain a clear liquid which soon becomes cloudy and discharges pus. The gangrene itself remains a dry type of lesion. The skin lesions in the other regions of the body, the neck, genital areas and toes and the case of the widespread disseminated lesions of the skin[2] seem to follow an almost identical course.

There is one skin condition which closely resembles acute infectious diabetic gangrene and that is the lesion described by Melleney[3] which has occurred in non-diabetics and which is produced by a hemolytic streptococcus. The differential diagnosis is based upon the organism involved. Occasionally it has been suspected that the large lesions of the skin may be carbuncular. This dry gangrene of the skin is easily distinguished from the carbuncle in which there is usually a large central necrotic area discharging pus from many small openings in the skin. This deep necrotic lesion, if left alone, eventually sloughs out and leaves a large crater with

has been recovered, with the aureus type predominating. In this case in which the toe was involved both a hemolytic streptococcus and staphylococcus organism were found in mixed culture.

It has been suspected by several observers[1,4-6] that the underlying pathologic process involved in the production of these localized areas of acute infectious diabetic gangrene has been acute arteritis and thrombosis of the terminal arteries to these structures precipitated by the underlying inflammation and edema. This has been strikingly demonstrated in the pathologic report in the case of amputation of the toe when it was observed microscopically that an acute thromboangiitis obliterans existed. Arteriosclerosis does not play an important factor in the underlying process as evidenced by the fact that acute infectious diabetic gangrene occurred in several patients under ten years of age and also that the gangrene occurred in those areas normally not affected by arteriosclerotic processes. Even in this case involving the big toe in which arteriosclerosis might be expected to be an underlying factor in the production of diabetic

TABLE III
DIABETIC GANGRENE OF THE CHEEK

Author	Age (yr.)	Sex	Area Involved	Organism	Complications	Treatment	End Result
C. H. Bowers. J. A. M. A., 1924.	10	M	Left eyelid, left cheek, lower left lid left side of nose, left cheek out to zygoma and left upper lip to median line	....	Coma, probably due to diabetes and septicemia	Diet	Died
H. A. Bulger. J. Missouri M. A., 26: 304, 1929.	21	F	Started with stye left lower eyelid; left eyelids, spread to right eyelid; left half of nose; inner half left cheek; inner half of supraorbital ridge	Hemolytic Staph aureus	Proptosis left eye; coma, probably due to diabetes and septicemia	Insulin; diet	Died
G. B. Brook. Brit. M. J., 2: 539, 1929.	60	M	Cheek under right orbit; spread to eyelids on both sides	....	Proptosis right eye; coma, probably due to diabetes and septicemia	Insulin; diet	Died
A. J. Brier. J. A. M. A., 103: 1704, 1934.	24	M	Anterior to right ear spreading to above hairline and below to angle of jaw; gangrene of upper half right ear temporal and preauricular area	....	Right fifth and seventh nerve injury; tongue deviates to right with anesthesia of right half and also masseter muscle of cheek; right arch soft palate and right masseter muscle paralyzed; right eyebrow cannot be raised or right eye closed; right nasolabial fold smooth and angle of mouth droops	Insulin; promotion of drainage	Lived
J. Millett. J. A. M. A., 112: 1143, 1939.	47	M	Right cheek, right eyelid, then left eyelids and left cheek	Staph. aureus; also on blood culture	Septicemia; coma autopsy: metastatic abscesses to lungs	Diet; insulin	Died
	55	F	Right cheek; submaxillary region right neck, right upper lip to midline.	Staph. aureus also on blood culture	Septicemia; coma	Diet; insulin	Died
B. R. Dysart. Arch. Otolaryng., 41: 143, 1945.	47	F	Below left eye; erysipelas-like area; left side hard palate; gangrenous area	....	Sharply demarcated gangrenous area below left eye; sharply demarcated gangrene of the hard palate	Insulin; intravenous dextrose and sulfanilamide	Died; septicemia? pulmonary edema

TABLE IV

DIABETIC GANGRENE INVOLVING THE MAXILLARY SINUS

Author	Age	Sex	Area Involved	Organism	Complications	Treatment	End Result
B. R. Dysart. *Arch. Otolaryng.,* 41: 143, 1945.	52	M	Roof of mouth	....	Gangrene and perforation of hard palate; gangrene lower and middle turbinate, left nostril; gangrene ethmoid cells	Removal of slough by forceps; insulin	Lived
	69	M	Erysipelas below left eye; gangrene of roof of mouth, left side	....	Gangrene and ulceration below left eye, penetrating into left antrum; gangrene of roof of mouth penetrating into left antrum	Removal of slough; insulin	Died 6 mo. later of bronchopneumonia

TABLE V

MISCELLANEOUS AREAS

Author	Age (yr.)	Sex	Area Involved	Organism	Complications	Treatment	End Result
Sturgis. *Boston M. & S. J.,* 124: 261, 1891.	64	M	Right side of upper lip	....	None	None; spontaneous drainage	Lived
H. A. Bulger. *J. Missouri M. A.,* 26: 304, 1929.	65	M	Right half of tongue	....	None	Surgical removal right half of tongue	Lived
S. S. Riven. *Am. J. M. Sc.,* 189: 550, 1935.	40	F	Disseminated blebs over entire body with gangrenous base	Staph. aureus	None	Localized drainage; general treatment of diabetes; insulin	Lived
H. R. Deeher. *Pennsylvania M. J.,* 45: 596, 1942.	Sixty-five collected cases		Lung	Mixed infections	Spread to pleural cavity	Operated, thoracotomy (39) Non-intervention (26)	Dead 18% Lived 58%
J. Millett and R. T. Darby. *New England J. Med.,* 235: 12, 1947.	51	M	Entire skin of back of neck	Staph. albus; Staph. aureus	None	Intramuscular penicillin; insulin; diet	Skin intact; lived

gangrene in this area, clinical observation revealed full and bounding posterior tibial and dorsalis pedis arteries and the oscillometric readings were normal. This pathologic process not only involves soft tissues but also attacks such structures as cartilage and bone as shall be noted.

The clinical picture in these cases can be considered to be initiated by a localized infection. The diabetic is known to be extremely susceptible to infection. Trauma, however slight, may be considered as a precipitating factor. The ever present staphylococcus needs very little encouragement when the defenses are weakened under such conditions. Localized inflammation and edema with accompanying acute arteritis of the terminal arteries, thrombosis and subsequent necrosis of the tissue results in localized gangrene.

The complications involved in acute infectious diabetic gangrene are those pertaining to the diabetic condition itself and to the localized lesion. Those due to the former are the intractability of the disease under such conditions and subsequent coma. Those due to the localized lesion are many and varied depending upon the site of the lesion, the structures involved and the extent and depth of the underlyinfection. These complications may be considered to be local destruction of the soft, cartilagenous or bony tissue by direct continuity.

This is particularly noted with those lesions in the intranasal region in which the gangrene may extend directly into the adjacent areas, notably the sinuses. Gangrenous involvement of the bones of the face and the cartilagenous septum of the nose is seen as well as edema and inflammation of the overlying skin, facial nerve paralysis, optic atrophy and proptosis of the eye. Complications noted in involvement of the cheek have been destruction of peripheral facial nerves with subsequent paralysis of facial muscles, proptosis of the eye and spread to the general circulation with septicemia and metastatic abscesses. Two cases involving the skin of the

nose have resulted in destruction of the underlying cartilage of one of the alae nasi in one instance and in the other a destructive gangrene which resulted in spontaneous amputation of the entire nose, together with partial destruction of the superior maxilla and nasal bones.

From the standpoint of prognosis, acute infectious diabetic gangrene is not necessarily fatal. Practically all of the patients with diabetic gangrene involving intranasal structures and adjacent sinuses lived as did those with gangrene involving the hard palate, eyelids, skin of the face excluding the cheek, genital organs, tongue, lip, neck and toe. Only one case involving the septum and turbinates ended fatally and that was in the pre-insulin era.[7] All those cases directly involving the cheek were fatal. This could be attributed in practically all instances to generalized septicemia.

Treatment will depend largely on the individual patient and the area involved, based on the knowledge of the manifestations and variations present in the cases already reported. The diabetes itself must be controlled to the greatest possible degree with insulin, diet, fluids and general supportive treatment. The amount of insulin should be governed solely by the status of the blood sugar. Those lesions involving the intranasal structures and adjacent sinuses seem to do very well when the treatment is limited to the removal of gangrenous areas by thumb forceps where the necrotic tissue is seen to be sloughing off of its own accord. The same is true of those lesions involving the hard palate. In these cases follow-up treatment with prosthetic devices gave satisfactory results. Actual major surgery has been used only in three instances; involving the right half of the tongue, the large toe and the lung. It is noteworthy that when a thoracotomy was performed, 18 per cent of thirty-nine patients died. In twenty-six cases in which there was non-intervention surgically, 42 per cent of the patients died. In the lesions involving the skin of the face, notably the

cheek, the bridge of the nose, under the eyelids, the genital areas, the lip and the disseminated skin lesion, the treatment was purely that of watchful waiting. This type of therapy also was the one employed necessarily when the lesions in the intranasal areas and adjacent structures bored through to the overlying skin. This, naturally, was an unsatisfactory form of treatment as the infection could not be controlled.

The ideal treatment would be some method whereby the infection could be controlled rapidly once the clinical diagnosis had been made. This would prevent the spread of cellulitis and edema beyond the original focus and thereby obviate gangrene of adjacent structures. Penicillin seems to be an ideal agent as the chief offender is the staphylococcus organism. To date it has been employed in two cases in which it has appeared to have had a profound effect upon the lesion. In the case involving the entire back of the neck[6] there was a dry gangrene from the hairline down to the shoulders and over to within the line of both ear lobes. In spite of this extensive gangrene which was dry and leathery and which one would have expected to slough out entirely, the depth of the gangrene was so limited that it did not involve the baselar layer of the skin and the underlying fascia. Within six weeks the entire lesion had disappeared completely. This no doubt can be attributed to the rapid control of the underlying cellulitis by the large doses of penicillin given.

In spite of profuse drainage in our patient, the administration of penicillin caused an immediate drop in temperature to normal within twenty-four hours at which it remained for the duration of observation, a period of twenty-four days before surgical intervention. It was also noted that in spite of severe diabetes and a complication of soft tissue and bone infection in addition to the gangrene of the skin, infection in this region remained localized and did not travel beyond the original site.

SUMMARY

1. Acute infectious diabetic gangrene can be regarded as a clinical entity having a distinct clinical course and its own definite pathological pattern.

2. Treatment is mainly conservative. Penicillin, in view of the offending Staphylococcus organism, can be thought to play a major role in both treatment of the disease and prevention of its spread. It may prove life-saving in cases of septicemia.

3. A case of acute infectious diabetic gangrene of the skin of the large toe, secondary to a cellulitis of the toe as a result of a perforating ulcer on the ball of the foot, is reported which has given additional valuable information regarding pathology and treatment of this condition.

4. Internists and surgeons should be aware of this complication of diabetes mellitus.

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MULTIPLE SPINAL WEDGE OSTEOTOMY*

ITS USE IN A CASE OF MARIE-STRUMPELL SPONDYLITIS

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THE discouraging results obtained by conservative measures in the correction of severe flexion deformity of the spine in Marie-Strumpell's spondylitis have led to the seeking of a surgical approach in the method of treatment. Recently reports[1,4] have appeared in the literature dealing with surgical principles and technics involved in correction of this deformity.

During the time our case was considered for reconstructive surgery and the method of correction carried out, osteotomy of the spine as described by Dr. Smith-Petersen and more recently by Dr. E. H. La Chapelle had not reached our attention. In view of the surgical magnitude and associated hazards accompanying the technics described in their reports we are presenting our experience in the hope of demonstrating a simplification of surgical technic designed to secure the desired correction.

If one considers the ankylosed vertebral column as a single bone, the use of the term spinal osteotomy appears justified in describing surgical sectioning of the column for the purpose of correcting deformity. Actually the procedure does not involve the vertebral bodies proper but is confined to the posterior elements, namely, the articular facets and adjacent lamina. In some cases it may be necessary to attack the anterior elements, namely, the anterior spinal longitudinal ligaments and intervertebral discs.[1] Osteotomy of the spine had been done previously to correct other types of spinal deformity.[2] In 1934 Dr. Leo Mayer, in order to correct a recurrence in a previously fused scoliotic spine, created a pseudo-arthrosis by re-secting 1 to 1½[1] inches of bone with exposure of the dura in the fused area.[3] The present report confines itself to the correction of the malaligned spine in patients with Marie-Strumpell spondylitis.

CASE HISTORY

Patient C. M., male, aged thirty-one, (No. 148400), entered the orthopedic service of the Metropolitan Hospital on August 2, 1944. The onset of his illness began in March, 1942. While recovering from pneumonia he experienced pain for the first time in the dorsal region of his spine. This was followed by forward bending of the spine with inability to straighten out. The curvature became more marked and extended to the cervical region. For a period of two and a half years the patient was treated at different institutions by the use of traction and the application of plaster jackets. At the time of admission to the Metropolitan Hospital the patient presented the severe flexion deformity illustrated in Figure 1. He was barely able to see on the horizontal plane; lying in bed was an ordeal. He was thoroughly discouraged and in a very depressed mental state.

Examination of the patient revealed the spine to be completely stiff except for 30 degrees' lateral bending and about 30 degrees' flexion and extension of the head from the flexed position. There was marked flexion of the cervical and dorsal spine which formed an angle of approximately 60 to 70 degrees with the upright. There was a full range of motion of the upper extremities. Flexion in the hips was present to 45 degrees, hyperextension to 15 degrees and abduction possible beyond 45 degrees. The knees were normal. There was considerable decrease of the thoracic excursion with absence of normal costovertebral motion. Roentgenograms showed partial fusion of the sacroiliac joints, fusion of the lumbar, dorsal
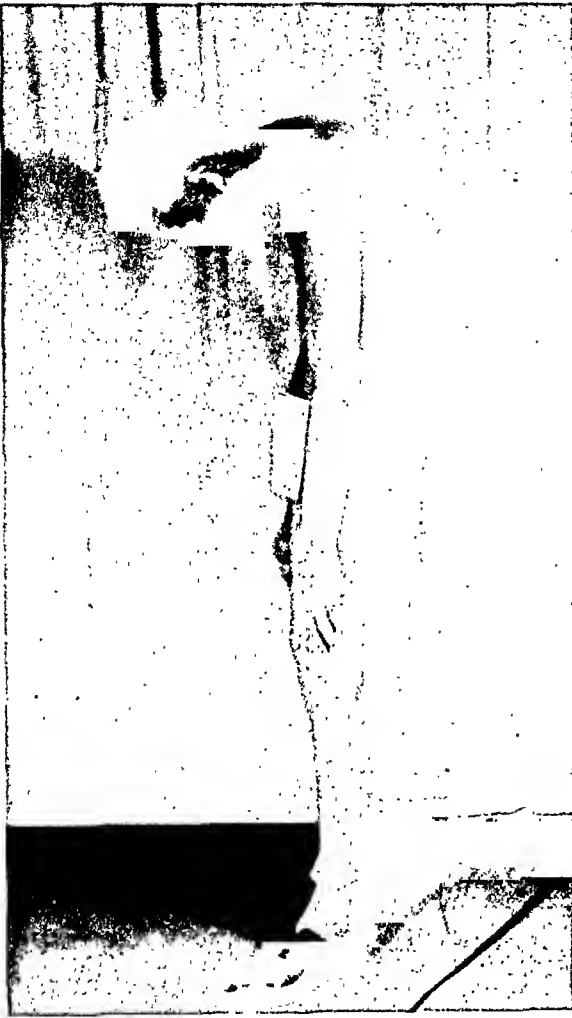
FIG. 1. Preoperative photograph taken August 5, 1944; height measured 4 feet, 9 inches; height prior to onset of illness, 5 feet, 10½ inches. The cervicodorsal spine forms an angle of about 60 to 70 degrees with the upright.

FIG. 2. Taken August 4, 1944; shows reversed curvature of lumbosacral spine at time of admission. Note obliteration of the apophyseal joints in the lumbar region and absence of calcification of the longitudinal ligaments of the spine. Arrows indicate sites at which subsequent correction was most marked.

and lower cervical apophyseal joints, marked dorsal kyphosis and reversal of the normal lumbar and cervical curves. (Fig. 2.) Sedimentation rates varied from 18 to 58 mm. per hour. The findings were consistent with Marie-Strumpell arthritis.

Complete fusion of the lumbar apophyseal joints was present as evident by the obliteration of their interarticular spaces. (Fig. 2.) At operation this fusion proved to be osseous in character completely replacing the cartilage-covered articulating facets. It was evident that what amounted to a solid bridge of bone had formed rigidly fixing the lumbar spine. In the absence of demonstrable calcification of the spinal longitudinal ligaments it appeared likely that correction of the deformity could

be accomplished by performing multiple wedge resections of the apophyseal joints. The outline of the wedge having the broad base posteriorly should correspond as closely as possible to the contours of the articular facets. Complete resection of the joints with unroofing of the vertebral canal was not contemplated. It was believed that by this procedure a number of potential spaces could be created which, under application of corrective laverage, would permit multiple angulated osteotomy of the bony bridge with concomitant correction of the lumbar curve. On August 29th with this in mind, wedge resections at the apophyseal joints were done between L2-L3, L3-L4 and L4-L5, respectively. The adjacent contiguous portions of the lamina and spinous processes, which by mechanical impingement prevented angulation, were also resected. This is schematically outlined in Figure 3. Corrective leverage was applied in the form of hyperextending the spine by overhead pulley traction on the feet of the prone patient while

Fig. 4. A, taken October 7, 1944, six weeks after the first operation; note correction obtained in the lumbar curve; anterior widening of the intervertebral space is present between L2 and L3 (arrow). The amount of bone removed from the apophyseal joints of L3-L4 and L4-L5, respectively, while sufficient to permit effectual application of corrective forces, was not enough to demonstrate anterior widening of their intervertebral spaces.

Fig. 3. Tracing of the preoperative film (Fig. 2) showing schematically the osseous bridge of bone formed by fusion of the articulating facets; the shaded areas, corresponding to the outline of the fused facets, represent the portions to be resected between L2 and S1. The broad base of the wedge faces posteriorly thus permitting angulatory osteotomy. Exposure of the intervertebral canal is not made. In the second operation angulatory osteotomy of the lumbosacral joints was ac-

manipulation was made by several quick and measured downward thrusts at the sides of the lumbar kyphosis. To maintain the correction secured, a Hibbs fusion from L2 to L5 was done and a plaster jacket applied.

Six weeks later the cast was removed and x-rays taken. (Fig. 4A.) Since it was deemed desirable to secure further correction of the patient's attitude (Fig. 4B), another operation aimed at the lumbosacral articulations was done on November 9, 1944. At this time it was believed that greater angulation might be effected by a complete hemifacetectomy with partial unroofing of the intervertebral canal. This was performed by total resection of the superior facets of the lumbosacral joints

complished by total resection of the superior facets with partial unroofing of the vertebral canal (hemifacetectomy).
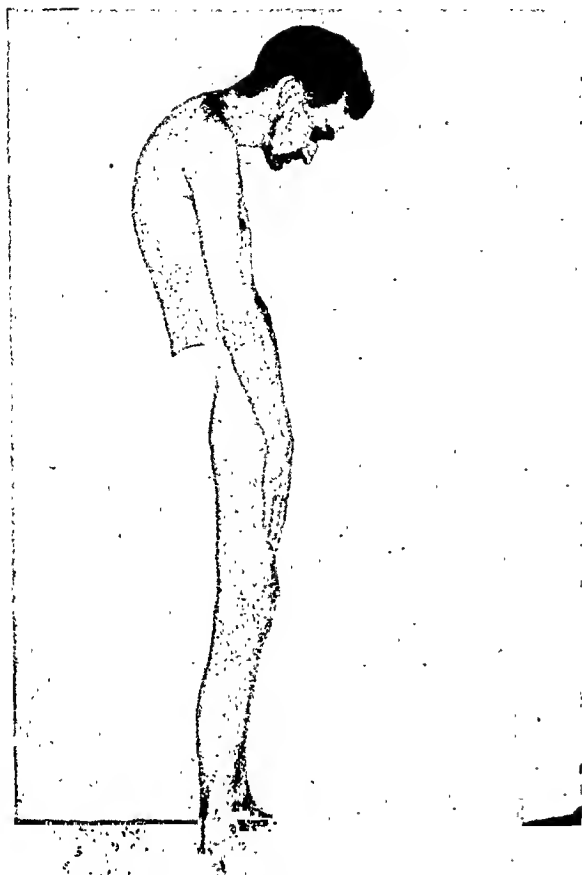
FIG. 4. B, taken November 1, 1944, nine weeks follow-ing the first operation; height now measured 5 feet, 3 inches, the patient having gained 6 inches.

FIG. 5. A, taken December 18, 1944, five and a half weeks after the second operation; demonstrates that in addition to the widening of the intervertebral space already noted between L2-L3, widening between L5-S1 has occurred.

(schematically illustrated in Fig. 3). In addi-tion, the transverse processes of the fifth lumbar were severed with an osteotome and the spine fusion carried down to the third sacral vertebra. (Figs. 5A and 5B.)

To evaluate the amount of correction due to relaxation of muscle spasm under anes-thesia, comparative roentgenograms of the cervical spine were taken just prior to and then during anesthesia. Before anesthesia there was a 7 inch elevation of the occiput from the horizontal. During anesthesia relaxation of the cervical spine occurred to the extent that the occipital elevation from the horizontal measured 4 inches. Despite application of cor-rective leverage no further correction could be obtained. The roentgenograms of the cervical spine showed that the correction obtained was limited to the joints cephalad to C4 in which there appeared to be minimal involvement by the disease process. In the more caudal articu-lations in which little, if any, correction was noted, involvement of the apophyseal joints

was evident. No change in the dorsal region of the spine was obtained or contemplated.

Following completion of the second operation the posterior displacement of the axis of the upper appendages with compensatory hyper-extension at the hips necessary to maintain an upright stance militated any further correc-tive procedure. (Fig. 5B.) Evidence of over-correction is an important factor since one must consider the ability of the patient to maintain an upright stance and secure hori-zontal and downward vision.

In view of the persistence of an elevated sedimentation rate it was presumed that the disease process was still active. Whether recur-rence of the deformity would appear despite the stabilizing effect gained by a spinal fusion could be judged only by the follow-up study. The immediate result was so good that the case was presented at the Orthopedic Section of the New York Academy of Medicine on May 18, 1945. (Fig. 6.) Complete mental re-habilitation had occurred in the patient and he was once again ready to face the world.

The following January the patient returned
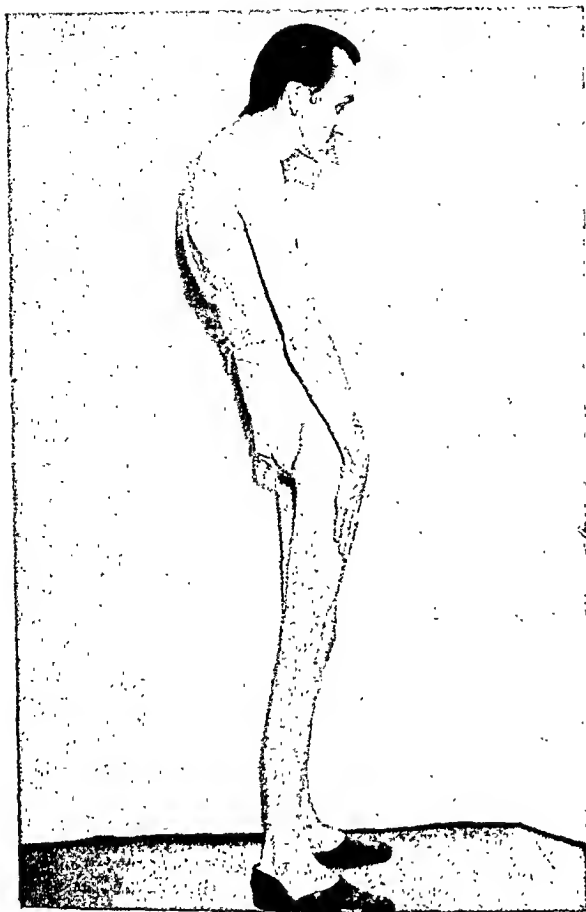
FIG. 5. B, taken December 21, 1944, six weeks after the second operation (lumbosacral hemifacetectomy); height now measured 5 feet, 5½ inches, a gain of 2½ inches following the first stage and a total increase in height of 8½ inches. Note the posterior displacement of the axis of the upper appendicular skeleton with the compensatory hyperextension at the hips necessary to maintain an upright stance.

for follow-up. During the interval he had worn a Taylor brace with head rest and chin piece (the patient could not tolerate a spinal jacket with moulded head and chin attachments). It was noted that some recurrence of the deformity had occurred. (Fig. 7.) Clinical and roentgenographic examination showed that the disease process was not only still active but that it had also progressed to involve the hip joints and the previously uninvolved cervical vertebrae. The patient complained of pain in his hip joints, particularly in the left. Abduction of the hips was now limited to 15 degrees on the left and 20 degrees on the right, (previously abduction was obtainable to beyond 45 degrees). The cervical spine had now fused into a rigid poker permitting only a small nodding motion of the head. However, the angle of the cervicodorsal spine did not return

FIG. 6. Taken April 15, 1945, six months after second operation; shows maintenance of correction obtained in lumbar spine.

to its previous flexed attitude of 60 to 70 degrees but formed an angle of about 125 degrees with the upright. Roentgenograms of the cervical spine showed absence of the joint spaces in the previously uninvolved apophyseal joints cephalad to C4. Comparison of the lumbar curves and dorsal curves showed a loss of about 10 degrees from the previously obtained correction. Careful study by tracings indicated that while some loss may have occurred in the operatively fused area, most of it occurred in the segments above L2, i.e., in that portion of the spine which had not been fused by operation.

COMMENT

The operation described differs from those since reported in the literature in that correction is accomplished by creating a number of potential spaces by either small wedge resection of the apophyseal processes or by a hemifaceteotomy. Complete wide unroofing of the vertebral column is not done. Attempting to correct the flexed spine by osteotomy at one level necessitates the more radical total facetectomy and wider resection of adjacent lamina creating a wide unroofing of the vertebral canal. This makes the technic of the operation

Fig. 7. Photograph taken April 22, 1946; shows recurrence of the spinal deformity. Note forward displacement of the upper appendicular skeleton and increased flexion deformity of cervical spine (compare with Fig. 5B). Height now measured 5 feet, 2½ inches, the patient having lost 3 inches. The cervicordosal spine forms an angle of about 125 degrees with the upright.

not only much more difficult but also increases the hazard of injury to the spinal cord and nerve roots by the possibility of subsequent slipping of the vertebra.

The technic described in this report is applicable in cases in which calcification of the spinal longitudinal ligaments is absent. When these structures are involved in the ankylosing process, it may be necessary to free the anterior as well as the posterior elements of the vertebral column in order to obtain correction. Here the two-stage procedure as described by Dr. La Chapelle may be attempted.

The end results in these cases should not be judged except by long, careful follow-up. In the case reported the immediate functional end result was much more striking than when studied at a longer time range. Due to the continued activity of the disease the progressing deformity of the spinal column proximal to the surgically corrected segment may, over a period of time, nullify the immediate end result obtained by surgery. Surgery should be judiciously appraised before attempting reconstructive procedures in these cases, particularly in those in which clinical evidence of activity is present.

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NEW AND SIMPLIFIED PROCEDURE FOR REPAIRING OMPHALOCELE[*]

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WE wish to report a case of congenital umbilical hernia or eventration into the umbilical cord of an infant and a simplified method of closure of the abdominal defect. It is the first case on record in the Sinai Hospital of Baltimore where 12,374 deliveries were performed in the past ten years. It is commonly stated, however, that this condition occurs once in 5,000 or 6,000 deliveries. Jarcho (1930) reported a case of congenital umbilical hernia and made an exhaustive review of the history and older literature on the subject. He found that the first description of this condition was made in 1634 by Ambrose Paré and that prior to 1800 only nine cases had been reported. The earliest of these was seen by Scultetus in 1643. Gradually more reports were made and by 1900 less than 200 cases had appeared in the literature of the whole world. Since 1900 the total cases reported has amounted to approximately 400.

Embryology and Description of Sac. The celomic cavity normally extends out into the expanded base of the umbilical cord and contains loops of intestine. After the tenth week of fetal life the abdomen enlarges at an accelerated pace and the intestines or other viscera present are withdrawn. However, if the abdominal cavity is retarded in development or the viscera grow at a greater pace, disparity occurs and a condition results at birth similar to that found in the 17 mm. embryo. A hernial sac is·present which may vary in size from approximately 1 cm. to 12 or 15 cm. The sac is covered by the peritoneum and Wharton's jelly. It is semi-transparent and the contents can be fairly well seen. The contents of this sac may be but a small loop of intestine or many loops with a portion of the liver, gallbladder and spleen and depend upon the size of the opening at the abdominal wall and not upon the size of the sac *per se*.

O'Leary and Clymer collected ninety-one cases from the literature and found that fifty-nine of the sacs contained multiple organs and thirty-two contained a single organ.

Treatment. Gross and Blodgett and Ladd and Gross have had perhaps the greatest experience and reported the largest number of cases (twenty-two) of this congenital anomaly. From this series they were able to draw a number of valuable conclusions regarding the treatment, complications and expectant results.

There is commonly an associated anomaly. Club feet, imperforate anus, harelip and hydrocephalus are observed. In the majority of cases, however, the babies are well developed except for the umbilical defect.

Although a few patients have survived such conservative treatment as adhesive strapping or alcohol compresses, it is generally agreed that immediate surgical treatment is indicated as twenty-four hours after birth the sac becomes dried and friable. Necrosis follows, resulting in rupture with evisceration or infection and subsequent peritonitis.

Gross et al. recommend excision of the sac and closure of the abdominal wall in layers as the ideal type of operation. However, this is not always possible or desirable as there is often insufficient room in the abdominal cavity to accommodate all the viscera and close all the layers of the abdominal wall. In such cases they have
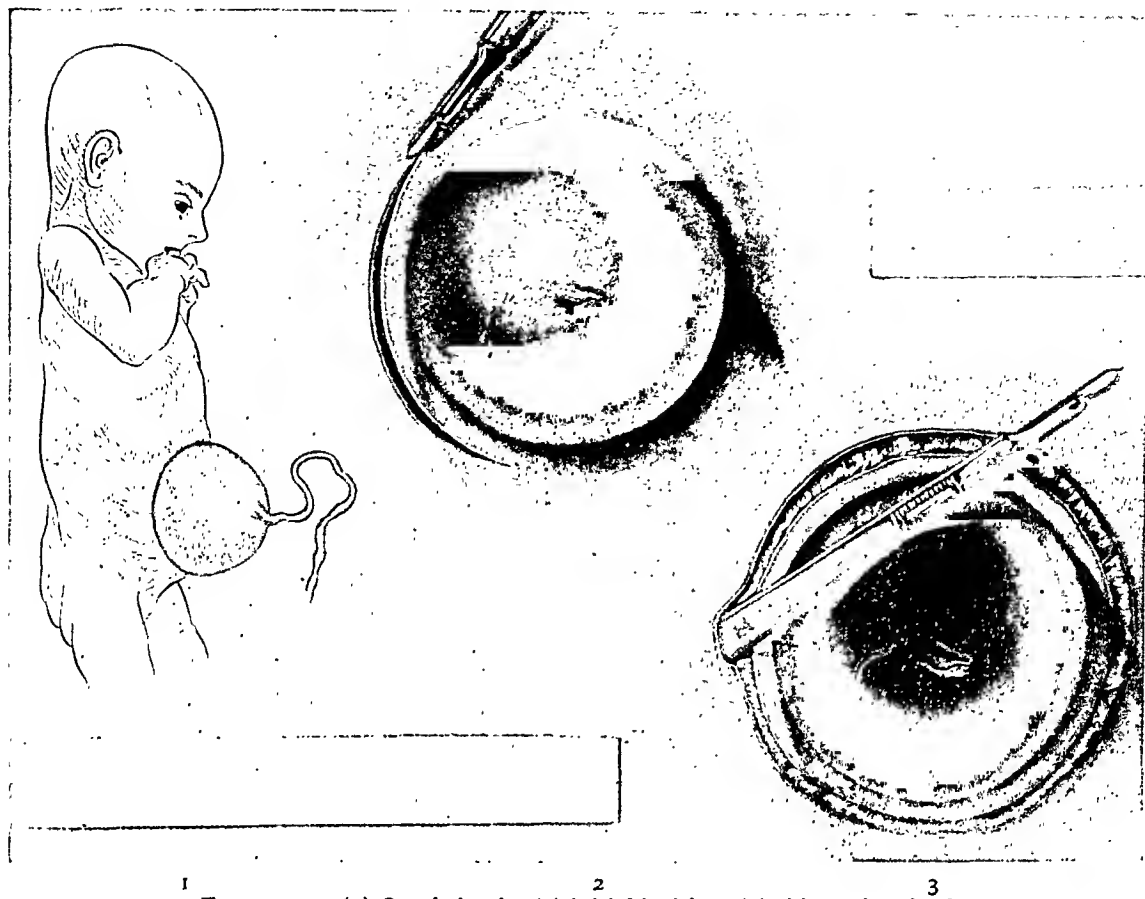
FIGS. 1 to 3. (1) Omphalocele; (2) initial incision; (3) skin undermined.

been content to do a two-stage operation and merely close the skin and subcutaneous tissue in the first stage and do a more complete repair subsequently. Furthermore, crowding of the abdominal viscera in a one-stage complete closure occasionally resulted in respiratory distress, circulatory or intestinal obstruction.

There was a 50 per cent mortality rate in this operative series (twenty) and analysis revealed that six of the eight who died had extruded liver in the sac. Also revealed was the fact that there was survival rate of only 15 per cent if the diameter of the sac was greater than 8 cm.

O'Leary and Clymer analyzed the mortality rate in seventy-eight patients operated upon in relation to the delay before surgery. When up to twelve hours had elapsed from time of birth, the mortality in fifty-six cases was 21.4 per cent; twelve to twenty-four hours in nine cases, 44.4 per cent; and after twenty-four hours

in thirteen cases, 61.6 per cent. They also found that resection of bowel or incomplete closure of the defect usually results in a mortality. Two patients expired following bowel resection, three following resection of a Meckel's diverticulum and two of three following incomplete closure in which the liver was sutured into the wound. Of nine patients treated conservatively, only one survived. Peritonitis is the most common cause of fatality. They reported that in two of the seventy-eight operations the hernia was repaired by the extraperitoneal methods. (The amnion and Wharton's jelly are removed from the peritoneum, the sac manually inverted and the anatomic layers are closed in turn.) They state that this procedure may be used when the hernia is quite small.

CASE REPORT

A. S., a male infant, was admitted to the Sinai Hospital, October 22, 1945, one and a
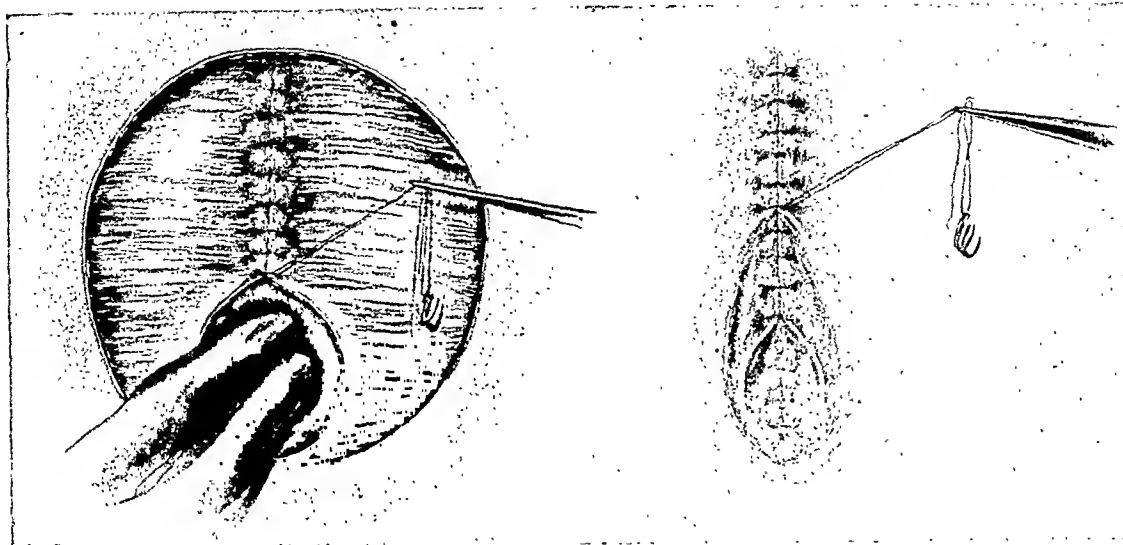
FIG. 4. First layer of sutures bring inner circle of skin together.
FIG. 5. Three consecutive layers in closure: skin, fascia, skin.

half hours after birth. He was the eighth child of a mother, aged thirty-seven, and father, aged forty-seven. The delivery performed at home by a mid-wife was spontaneous and at full term. There was no family history of congenital abnormality. The other seven children were perfectly normal and healthy.

On examination the child weighed 7 pounds and 6 ounces and was well developed. Protruding from the mid-region of the abdomen was a large transparent herniation into the umbilical cord. On close inspection the liver could be seen occupying the upper third of the sac, the remainder of which was filled with intestine. The sac was 9½ cm. in diameter and the umbilical cord had been tied about 7 cm. distal to it. Also present was a large left inguinal hernia which distended the scrotum to almost ten times the normal size for an infant. (Fig. 1.)

Under ether the abdomen was cleaned with ether, zephryn and alcohol. The umbilical cord, which had been tied at some distance from the sac, was retied flush with the sac with a piece of narrow cotton tape and was excised. An incision was then made through the skin about the circumference of the sac leaving approximately 1 cm. of skin attached to it. (Fig. 2.) The skin lateral to the incision was undermined for some distance on both sides exposing the anterior sheaths of the recti muscles. (Fig. 3.) Mattress sutures of fine black silk were passed through the skin margins of the sac and were tied as the sac was manually inverted. (Fig. 4.) Wharton's jelly was not

removed. After this first suture line was completed, it was found that the margins of the large abdominal opening had been completely approximated. A second suture line of interrupted fine black silk mattress sutures was then placed through the fascia of the anterior rectus sheaths on either side and tied without producing any tension. The skin was closed with interrupted black silk sutures. (Fig. 5.)

The infant was returned to the ward in good condition. Examination of the left scrotal hernia showed an increase in size and it was quite tense. Undoubtedly the increased pressure in the abdominal cavity, occasioned by the reduction of the omphalocele, had forced additional loops of intestine into the sac. (Fig. 6A.)

The convalescence was marked by frequent vomiting which continued to the thirty-fifth postoperative day. However, the bowels moved normally and the infant gained weight steadily. On the ninth postoperative day there was a separation of the wound edges for about 2 cm. in the center of the incision and the tape ligature which had been used to tie the umbilical cord was found lying free. A small portion of the sac was visible. The wound was strapped with adhesive and four days later the defect was closed with silk sutures after the fascial edges and skin margins were refreshed. The further course was not remarkable. The infant remained in the hospital until March 12, 1946, because the mother refused to take the child home. Examination on discharge showed a firm abdominal wall.

6A

6B

FIG. 6. A, photograph taken seven weeks postoperatively showing a greatly distended left inguinal hernia and the abdominal scar. The slight bulging of the abdominal wall above the scar is accentuated by the lighting. FIG. 6. B, photographs taken January 10, 1947; the inguinal hernia has been repaired but the child has a very large, protuberant abdomen. There is slight bulging of the abdominal wall which is less prominent than in Figure 6A.

The infant, aged 10 months, was readmitted to the hospital on August 16, 1946, for an acute respiratory infection. He had developed normally. There was a slight bulging of the abdominal wall but no herniation. The scrotal hernia was quite large. On September 16, 1946, the left scrotal hernia was repaired. When the hernial sac was opened, it was found to contain a loop of small bowel, cecum and appendix and a portion of the ascending colon. The mesentery of the right side of the large bowel was very long and the gut was not fixed to the right lateral peritoneum. The child made an uneventful recovery following this operation. (Fig. 6B.)

SUMMARY AND CONCLUSION

1. A case of congenital umbilical hernia is reported in which operation was performed five hours after birth of patient.

2. The sac was large and treated in much the same manner as one often treats the sac in a large ventral hernia, for example, the peritoneum (with the covering of Wharton's jelly) was not opened but manually inverted and retained by sutures placed through whole skin thickness attached to the sac margin. Sixteen months postoperatively no cysts had appeared as a result of burying this skin which leads us to believe that in infants at least whole skin may be buried with impunity.

3. The ultimate result is satisfactory. We believe it could have been better had we not made two errors in technic, namely, (1) we tied the cord with tape instead of with a piece of heavy catgut. The tape became free and acted as a foreign body, contributing to the partial separation of the wound; (2) we simply approximated the two uncut rectus sheaths instead of incising the fascia of the rectus sheaths on either side of the first suture line and bringing the raw edges together with the recti muscles.

4. We believe that with these modifications in technic a very simple method of closure is presented that is applicable to large omphaloceles as well as small and that there will be less shock accompanying this type of closure and a lower mortality rate.

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XANTHOMA OF THE STOMACH

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XANTHOMA of the stomach is a rare disease. Xanthomas of the joints, skin, mesentery and tendon sheaths[1] have been reported but it has not been possible to find references in the current literature concerning this tumor located in the stomach.

Xanthomatous disease is divided usually into primary and secondary xanthomatosis. Primary xanthomatosis is manifested by the appearance of multiple xanthomas on the skin or elsewhere[2] and, also, a hypercholesterolemia is present. Secondary xanthomatosis may be further divided into xanthoma tumor formation which occurs in organs following inflammation, granulomas or malignant change with xanthomatous formation. Some authors believe that an alteration of intracellular lipid metabolism occurs,[3] with resultant xanthoma formation locally. In these cases the blood cholesterol is normal and there are no systemic signs of xanthoma formation. In the cases of localized xanthoma formation observed by Thannhauser there is no milky serum or hyperlipemia and this process is thought by him to be the result of a local cellular disturbance.

Because of the paucity of tumors of this kind being found in the stomach, it was deemed of interest to record a case of fibroxanthoma of the stomach.

CASE REPORT

A forty-five year old white male had been coming to the office over a period of several years for various benign conditions since November 22, 1941. In July, 1946, after an absence of two years, he came to the office complaining of a burning sensation in his stomach for about two years, ever since he had had an attack of undulant fever. His appetite had been fairly good. His bowels were regular but he had not slept well for the past two weeks. There was no history of weight loss, change in bowel habit or tarry stools.

Physical examination revealed a white male weighing 155½ pounds. His temperature was 98°F., pulse 76, blood pressure 110/76, heart regular with no murmurs and lungs clear. Examination of the abdomen showed no masses, distention or scars. The liver, kidneys and spleen were not palpated.

At that time the impression was that he was suffering from flatulency and he was given dietary instructions and a capsule containing a digestive enzyme. A return visit by him one week later showed that he had less difficulty with abdominal distention or gaseous eructation and felt better.

An x-ray of the gallbladder and a short gastrointestinal series were advised. The x-ray report showed that the gallbladder functioned normally. No stones were visualized. A polypoid tumor mass about 3.5 cm. in diameter was found in the region of the antrum of the stomach. It appeared to be fixed to the walls of the stomach. We believed it to be a polypoid tumor of the stomach, most probably carcinoma. Blood Wassermann was negative, free hydrochloric acid, 8 and total acidity was 24. A blood cholesterol taken after surgery was performed was reported as 243 mg. per cent.

The patient was admitted to the hospital and prepared for a gastric resection which was performed on August 10, 1946. The abdomen was opened through a right rectus incision. There was a firm tumor about 2½ cm. in diameter in the prepyloric region near the lesser curvature of the stomach. The remaining portion of the stomach was negative. A posterior Polya gastric resection was performed, removing approximately 50 per cent of the stomach.

The patient had an uneventful convalescence from the operation and returned to work on September 10, 1946. Six months later a return visit by the patient showed that he was in good physical condition, working daily and had gained 10 pounds.

The pathologic report was as follows: "The

specimen consists of a resected pyloric end of the stomach. The specimen is 6 cm. along the lesser curvature and 12 cm. along the greater. A segment of omental fat 13 cm. long, 2.5 cm. wide, and up to about 1 cm. thick are included with this specimen. There are no nodules or changes in this fat tissue. There are no palpable lymph nodes along the lesser or greater curvature. The specimen includes about 2 cm. of the proximal part of the duodenum. There is no obstruction at the pyloric end of the stomach, and no changes in the lining of the duodenum. On the outside of the stomach in the anterior wall about 6.5 cm. from the distal level of resection, there is a peculiar subserous nodule elevated above the stomach at least 2.5 cm. It is cystic and 2.4 cm. in diameter. The serosa over it is smooth and glistening, as it is elsewhere over the stomach. At the same level as the protruding nodule, there is a nodule in the wall of the stomach which bulges somewhat into the lumen. This nodule is 3.2 cm. in diameter. It is continuous with the nodule protruding underneath the serosa. This is constricted in the center giving the mass a roughly hour-glass appearance. The mucosa is intact over the nodule; in fact, the entire mucosa of the stomach is unchanged. The specimen is fixed in formalin before further examination is made. Upon sectioning the mass, it is found that both the nodule beneath the serosa and the one protruding into the stomach are part of the same nodule. The tumor consists of a firm, light, gray-tan tissue. The nodule beneath the serosa is cystic, and this is caused by extensive recent hemorrhage into the tumor. (Fig. 1.)

"*Microscopic:* A large number of sections are examined from different parts of the tumor as well as with special stains. The tumor consists of a fibroblastic-like tissue. Most of the cells are roughly stellate-shaped while a large number are spindle-shaped. The cells in most places are quite large and clear. The outstanding finding of the cells is that of a very abundant finely-foamy cytoplasm with clearly defined cell outlines. The nuclei are round to oval. They are small in comparison to the amount of cytoplasm. They are not hyperchromatic. No cell is observed in mitosis. Although the majority of the cells show the finely-foamy appearance of the cytoplasm, there are many in which there are large clear vacuoles. In a section stained with phosphotungstic acid the

FIG. 1. Gross specimen; mucosal appearance of tumor after opening stomach; cut section on right.

cytoplasm of the cells stains with a very pale, barely visible orange color. No collagenous fibrous tissue has been laid down between the cells. The stain brings out clearly the short processes given off by the cells. These appear to join the processes of other cells thus forming a syncytium-like pattern. In a section stained with Masson's stain, the cytoplasm stains a light blue. However, the clear vacuoles do not take any stain. Several sections were stained for fat with Sudan 3. Neither the large clear vacuoles nor the foamy cytoplasm take the stain. In view of the staining qualities of the material within the cells, it is believed that the material is a lipid material closely related to the cerebrosides. These lipids stain blue with Mallory's aniline blue stain. An interesting finding in all sections is that the tumor apparently arose beneath the serosa because on one side it is covered by serosa and on the other side by gastric mucosa, submucosa, and muscular layers. None of the layers show any change." (Figs. 2 and 3.) This tumor represented an isolated tumor which showed some xanthoma cells.

COMMENTS

Tumors of the stomach are not uncommon and if one is to err regarding the surgical treatment of a given tumor of the stomach, it is believed wiser to err on the side of being radical than conservative. At times it is very difficult to determine the nature of a gastric tumor, even when the stomach is held in the surgeon's hands.

The discovery of a benign tumor after operation, when it was thought to be
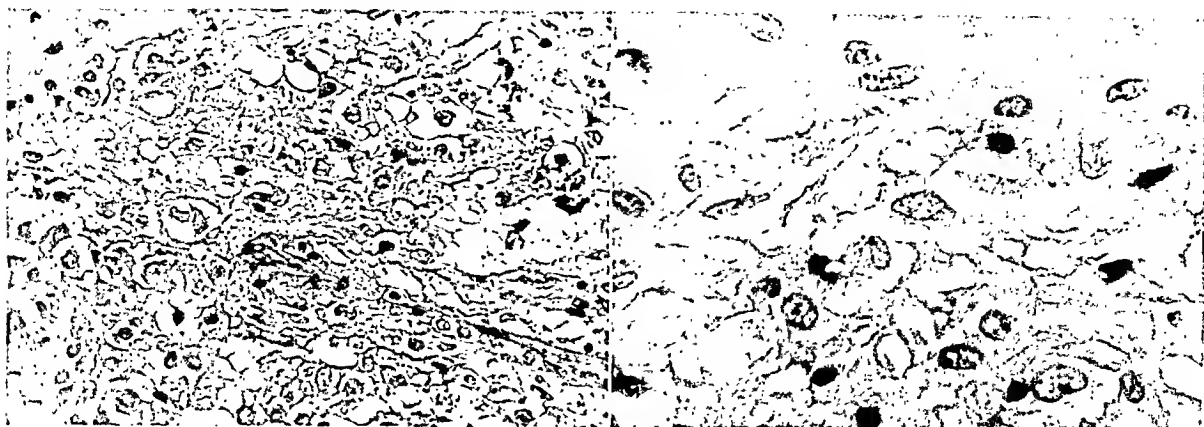
FIG. 2. Note vacuolization and degeneration of cells; low power of tumor × 280.
FIG. 3. Note finely granular cytoplasm with higher magnification; high power × 1000.

malignant, is a pleasant surprise for the surgeon and patient. The prognosis is much more favorable when the diagnosis of benign tumor of the stomach is recorded by the pathologist.

It is of no significance, probably, that the patient developed symptoms referable to the gastrointestinal tract following an attack of undulant fever. The location of the tumor near the pylorus was undoubtedly a factor in interference with gastric motility which, in turn, warranted further investigation of the gastrointestinal tract.

The presence of a free gastric acidity of 8 and a total acid of 24 indicated that the parietal cells of the gastric mucosa were still functioning. Whereas the absence of gastric hydrochloric acid predisposes to putrefaction and infection, the presence of free hydrochloric acid seems to inhibit these processes; undoubtedly, it played a role in the smooth postoperative convalescence.

SUMMARY AND CONCLUSIONS

A case is presented of a tumor of the stomach, thought to be malignant before and during surgery, which was proved to be a xanthoma.

A "secondary" xanthoma of the stomach is recorded. The patient was living and well nine months after a posterior Polya-type of gastric resection.

We are indebted to Dr. O. O. Christiansen for the pathologic examination.

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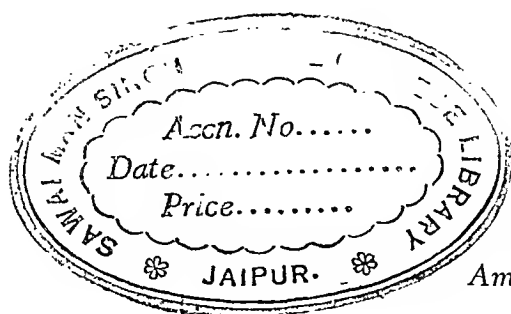
COURVOISIER'S LAW

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AS medical students we are subjected to a variety of pedagogical dogmas which occasionally prove to be misleading when evaluated in the light of clinical experience. Just so with Courvoisier's law, variously stated by different authors. According to Christopher, "A sign of great importance (in the differential diagnosis of obstructive jaundice) is the finding of a greatly distended gallbladder which moves with respiration. In the presence of jaundice this is significant of obstruction other than stone. Stone in the common duct is almost always preceded or accompanied by a chronic cholecystitis with thickening of the walls of the gallbladder which prevents dilatation." Callender states more positively: "In obstruction caused by carcinoma of the head of the pancreas the gallbladder is dilated by the gradual accumulation of bile, whereas, in obstruction resulting from gall stones, the gallbladder is contracted." Foot says, "One should not take Courvoisier's law too strictly, although it is true that distention of the gallbladder usually follows pressure from without the ducts such as that which results from carcinoma of the head of the pancreas, and does not follow impaction of stones in the ducts."

Others imply that the law should not be taken too seriously for the reason that carcinoma of the head of the pancreas is by no means always accompanied by distention of the gallbladder; but that when distention does occur, it is almost certainly due to carcinoma of the pancreas and not to stone. Brunschwig states that a palpably distended gallbladder in the presence of obstructive jaundice strongly suggests that the obstruction is on a neoplastic basis, whereas the absence of a distended gallbladder suggests that the obstruction is due to a stone. He states further, however, that too much reliance should not be placed upon such clinical findings because the gallbladder may be markedly distended but not palpable for a variety of reasons, such as an enlarged liver which overlies the gallbladder, thick abdominal wall, etc.

The following cases are presented to illustrate two facts: (1) the clinical history and whatever help the laboratory can give constitute the basis for a differential diagnosis of obstructive jaundice and (2) Courvoisier's law should be ignored if it fails to fit into the clinical picture.

CASE REPORTS

CASE I. A seventy-four year old white female entered the hospital with a history of painless, progressive jaundice of eight months' duration. During the past two months her stools had been clay-colored and her urine a mahogany brown in color. During this two months' period she had suffered a 20 pound weight loss. A physical examination found her to be jaundiced and edematous. Her abdomen was distended with fluid. On one occasion there was a questionably palpable mass in the right upper abdomen, but the general concensus was that there were no palpable abdominal masses. Her stools were positive for occult blood. The icterus index was 55 units. The urine was positive for bilirubin and negative for urobilinogen. She became comatose shortly after hospital admission and died. Postmortem examination revealed a markedly distended extrahepatic biliary system due to carcinoma of the head of the pancreas. (Fig. 1.)

CASE II. A sixty-eight old white female was first seen in her home and the history she gave her physician was that she had had repeated attacks of biliary colic for thirty years. During the past year she had lost 40 pounds in weight. In the present episode she was first seen on the evening of September 1st when she began to
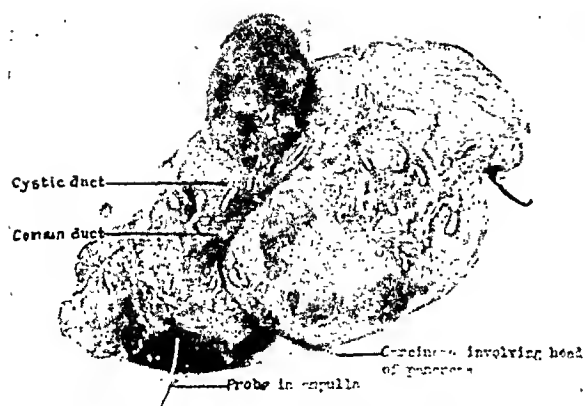
FIG. 1. Distention of the gallbladder and ducts due to carcinoma of the head of the pancreas.

FIG. 2. Distention of the gallbladder and ducts due to a stone in the common duct.

suffer with right upper quadrant abdominal pain radiating to the tip of the scapula which began after eating a meat pie. The pain was relieved by a hypodermic injection of dilaudid. On the following evening she awakened with a chill, temperature of 102°F., and pain in the right upper abdominal quadrant. The pain was again relieved by dilaudid. On the morning of September 3rd she became jaundiced and stuporous and was sent to the hospital. Physical examination revealed a jaundiced elderly female in coma. There was a soft, round, movable mass beneath the right costal margin. She died seventeen hours after hospital admission. Postmortem examination revealed a markedly distended gallbladder and ducts due to the impaction of a single huge stone in the common duct. (Fig. 2.)

COMMENT

Courvoisier's law can be misleading. A palpably enlarged gallbladder may be present in obstructive jaundice due to a calculus. While the gallbladder may be distended in obstruction of the common duct due to carcinoma of the head of the pancreas, it may not be palpable for a variety of reasons.

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The Early Art of Surgery

III. THE EDWIN SMITH SURGICAL PAPYRUS

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IN addressing a group of surgeons in Chicago in the nineties, John Billings said that although no modern surgeon possessed of all the knowledge and resources available would discover any new technic or knowledge by a perusal of the methods the old masters used, he was of the opinion that they could read, compare and think; so doing it was fair to say that he would be a broader and wiser man, established on a better foundation. Billings acknowledged that there were a great many men who had neither time nor accessibility to search collections of original material, and it was his opinion that short essays that did not take up too much time should be made available to these men by way of the surgical journals. It is with such a thought in mind that one justifies inflicting this sort of material on an editor.

By opening this series with a comment on the Ebers Papyrus one accomplishes a literary chore successfully, namely, one can skip over a period of about 4,000 years before there is anything in surgical literature which can be classed as specifically informative.

The art of surgery in these early days was sharply limited because of many surrounding environmental factors. Before the time of Christ there was the Jewish abhorrence and aversion to blood. After Christ the religious shrank from doing anything to the body in the belief that it interfered with God's own handiwork. In most instances those who called themselves surgeons were afraid of venturing far, subconsciously frustrated by the inward knowledge that they were not capable and did not know the way. Knowledge of anatomy, a necessary partner to surgery, was totally lacking. Therefore, is it any wonder that honest men were timid?

During the Crusades the story is told of a certain grand duke, a member of a party making the pilgrimage. He was so fat that he tired too easily, thus holding up the progress of the expedition; in addition, he suffered excessively from the heat. A surgeon accompanying the expedition was ordered to do something about it. He did. It was one of the earliest actually recorded cases in which the operation was successful but the patient died. The doctor cut into his noble patient's belly and removed all of the fat. The patient died that night.

On another occasion a grand duke fell from his horse, with a resulting compound fracture of the leg. After a few days it was a black, gangrenous leg. The surgeon accompanying this group would not amputate. Therefore, the duke placed a well sharpened battle axe across his leg below the hip and ordered his man servant to hit it and hit it hard with a heavy hammer. Three blows and the axe went through and the leg fell off. The duke died a few hours later. No word was mentioned about bleeding. These were certainly the men of distinction of their day.

To trace the story of surgery from the beginnings down through time is not only intriguing and inviting but is inspiring as well. It is a manifest testimonial of the ingenuity of the human mind. The paths of deviation in ideas and methods is, at est, a crooked one to trace because it is a

Fig. 1. Osseous tumor of tibia taken from J. H. Breasted's "The Edwin Smith Surgical Papyrus."

story of humans, their fallibilities, brilliant minds and the neo-brilliant (those who have managed to shine through without any right to do so), great thinkers, humanists and philosophers and with it all just enough of a sprinkling of crooks, quacks and many, many just plain "nuts."

Surgery has had its peaks and valleys in the point of estimation in the peoples around it. Discredited and in disrepute at times, almost extinct at various times—that part of it which has been honest has survived. What hurdles it has had to negotiate successfully: crazy kings who made it go underground to survive; narrow-minded bigots in high places who delighted in issuing edicts in attempts to strangle it; ecclesiastic interferences for centuries either based on religion or on the shekel; and superstition, incredulity, witches, medicine men, tribal customs and what have you.

In its time it has been the victim of intelligence, of ignorance, of the lofty-minded and cultured, and of liars and imposters, yet it has survived. How can the story of any parts of surgical progress possibly be without interest to those in the field? How can it help but be stimulating?

We have made a beginning using the Ebers Papyrus as a sort of jumping off point because it represents the first actual recording we have and, therefore, material proof of the surgical art of the time approximately sixteen centuries before Christ.

Before we transfer our attention to the great manuscripts, which is the next logical step in tracing our way, there is one other great papyrus we could hardly afford to leave behind without mention. That is the Edwin Smith Papyrus. This was acquired by a Mr. Edwin Smith at Luxor or Thebes. The exact year is thought to be 1862. Smith was a Connecticut Yankee, one of the first of American Egyptologists, who took his work seriously enough to live in Luxor for twenty years. Although Smith was unquestionably familiar with the fact that he had acquired a fabulously valuable piece of property, unlike Ebers, he made no attempt to sell it. After he died his daughter presented it to the New York Historical Society.

Egyptian writing was purely pictographic; a drawing or picture signified the thing it meant to depict. Imagine the labor of deciphering involved in a study of page after page of such material!

The first great evolutionary step forward in the field of surgery occurred when men recognized natural causes of disease rather then demons and spirits. From superstition to a scientific point of view was an absolutely necessary change.

The Edwin Smith Papyrus is of unknown authorship. Within it is, perhaps, the first attempt of man to write a clinical history. Under each case described a list is given of the objective signs or changes present as seen by the eye or palpated by the hand. An attempt is made to marshal these facts in an orderly manner so that the whole dovetails together into an entity. Along with this is an orderly discussion on how these lesions came about

with conclusions as to the cause of death and speculation on what might have been the antemortem picture leading up to death. Here then is the first recorded attempt at clinical diagnosis and the writing of a clinical history differing hardly any in format from that which we write today.

There is a considerable amount of scattered blurring in the papyrus, thus eliminating possible valuable segments or sections. Some of this blurring was probably done by the original Egyptian scribe who was trying for perfection and some was probably done by Edwin Smith himself, also striving for perfection, whereby in trying to eliminate minor defects he only increased them.

Man's mind was yet primitive; the mysteries of the human body baffled him because he had no plausible explanation as to the why; he was unable to grasp at logical conclusions based on observed fact.

Without entering controversy, the Smith Papyrus is presumably a work of the seventeenth century before Christ, and much of the material in it may be of as far back as a thousand years before that. Who compiled it, put it together? Nobody knows. Wishful thinking has desired to place it as the work of Imhotep, the earliest known physician, 1300 B.C., long before Hippocrates and long before Aesculapius. The surgeons of those days followed armies and did not have much civilian practice except as a side line. That is why so much of the material in this papyrus is on fractures inflicted anywhere, in the skull, face, arms or clavicles, by ingeniously designed, heavy, long-handled instruments for dealing such blows as would produce such wounds. Tops of heads would literally be knocked off; faces in all reality would be pushed into the occiput, not to mention eyes being knocked out any which way.

The arrow wounds, show that apparently arrows were aimed more for the abdominal area where tissues were soft; or we would like to believe that if a man were a particularly good shot, he aimed for an eye. You can let imagination run loose in any direction here.

These early days of surgery were the days of a science in the making. No technical terms existed; they had to be made up as the need arose. "Brain," "fracture," "compound fracture" had to be invented.

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